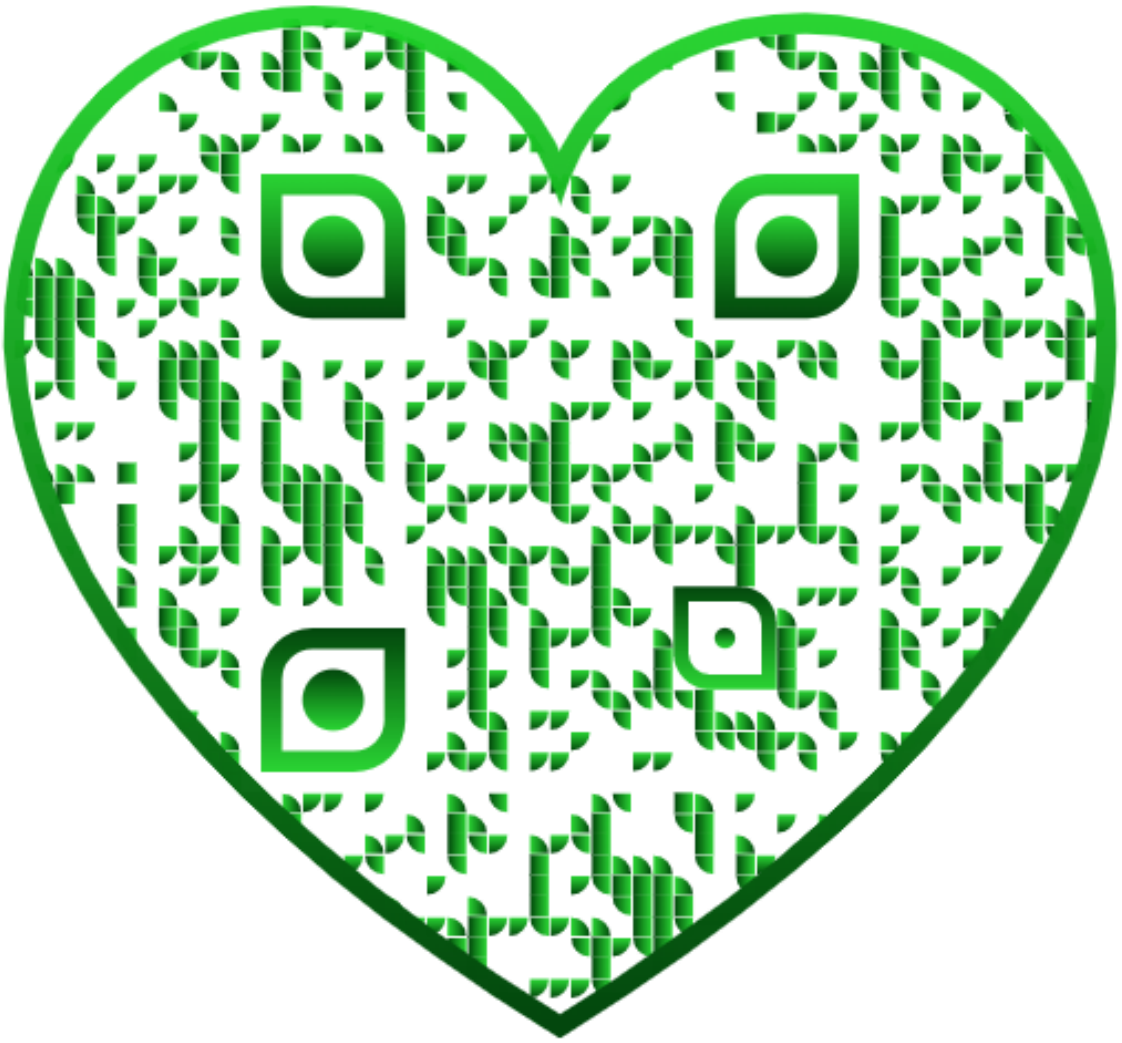
The Electric Sky

A Challenge to the Myths of Modern Astronomy

Donald E. Scott



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The cover picture is an image of the Helix Nebula, NGC 7293 taken by the author at his observatory in Arizona.

Preface

In recent years we have read about the ‘discovery’ of black holes, neutron stars, cosmic strings, and such things as dark energy and invisible matter. Anyone who reads Sagan, Hawking, and the other popular astronomy writers can see how complicated and counter-intuitive the concepts of modern astrophysics are becoming. Even so, until recently, I assumed that astronomers and astrophysicists knew what they were talking about.

Now – I’m sure they do not.

It was when astrophysicists began saying things that I, as an electrical engineer, knew were wrong that I began to have serious doubts about their pronouncements. But I agonized over whether those doubts were legitimate. Even though my life-long avocation has been amateur astronomy, my formal background is in engineering – not astronomy or cosmology.

Earning a doctorate in electrical engineering eventually led to my teaching that subject at a major university for thirty-nine years. What troubled me most was when astrophysicists began saying things that any of my junior-year students could show were completely incorrect.

If astrophysicists were saying things that were demonstrably wrong in ***my*** area of expertise, could it be that they were making similar mistakes in their own field as well? I began to investigate more of the pronouncements of modern astrophysicists and the reasoning behind them. This book is an account of what I unearthed when I started digging into this question.

It is becoming clear that knowledge acquired in electric plasma laboratories over the last century affords insights and simpler, more elegant, more compelling explanations of most cosmological phenomena than those that are now espoused in astrophysics. And yet astrophysicists seem to be intent on ignoring them. Thus, lacking these fundamental electrical concepts, cosmologists have charged into a mind-numbing mathematical *cul de sac*, creating on the way a tribe of invisible entities – some of which are demonstrably impossible.

I have tried to hack a path through these hypotheses, contradictions, and alternative explanations that will be clear and understandable for the average interested reader to follow. The answers to the questions we ask are not

stressfully convoluted and arcane – rather, they are logical, straightforward, and reasonable – and long overdue.

I hope your journey through these pages will be meaningful, educational, perhaps exciting, and most important of all, eye-opening.

Acknowledgements

I am deeply grateful to all those who have contributed to this work. Inspired comments from Dr. Anthony Peratt, Wallace Thornhill, and Amy and Mel Acheson have been invaluable and educational. While I was researching this material, they often stepped up and pointed me in the right direction. I owe them greatly for their help. Mel has edited the text in detail and made many crucial additions, suggestions, and corrections. Eric Lerner was most helpful in several ways and was a savvy guide through the corridors of my first cosmology conference. But for the efforts and encouragement of Michael Armstrong and his associates, this book never would have seen the light of day.

To my old professor of electric plasma, Dr. Gregory Stephan Timoshenko, who once gave me the grade – "A. But much room for improvement!" – I say, "Thank you, Timmie. I wish I had worked harder in your courses. I wish you were here."

My friend and colleague of many years, Dr. Lewis E. Franks, Professor Emeritus of the University of Massachusetts, read the manuscript and helped greatly with several probability calculations, the results of which are presented in the book.

I have visited the University of Arizona library often, and have, with permission, quoted private email communications and those posted for public consumption on several web lists. I have made liberal use of the Internet and its search engines. I have included several NASA and Chandra astro-images, as well as some of my own and those of my good friend and first-rank amateur astronomer John Smith of Hiddenloft Observatory, Oro Valley, AZ. Another friend, Hank May, has been most helpful in describing some specific experiences he has had while climbing along parts of the same controversial trek that is described in these pages.

My wife, Annis, who is more than half of this operation, has kept me on the straight and narrow – both editorially and temperamentally. I wondered many times while writing this whether my efforts could ever surmount the battlements of entrenched astrophysics. Each time I had major doubts, Annis picked me up, dusted me off, and helped me continue. Without her endless

patience, love, help, dedication, and insistence, this book would never have been completed.

Any errors still lurking in here are of course completely my responsibility and mine alone.

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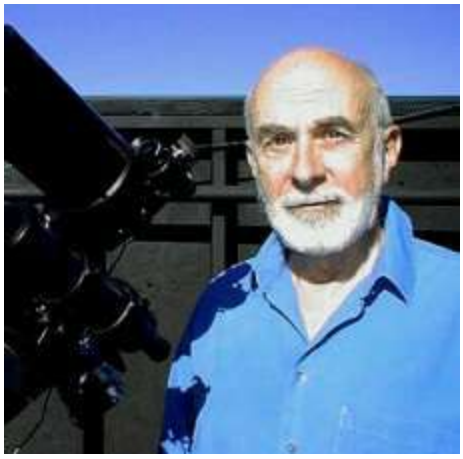
About the Author



The author earned his Bachelor's and Master's degrees in Electrical Engineering at the University of Connecticut in Storrs, CT. Following graduation he worked for General Electric in Schenectady, NY, and Pittsfield, MA. He earned a Doctorate in Electrical Engineering at the Worcester Polytechnic Institute, Worcester, Massachusetts, and was a member of the faculty of the Department of Electrical & Computer Engineering at the University of Massachusetts/Amherst from 1959 until his retirement in 1998. During that time he was the recipient of several good-teaching awards. He was, at various times, Assistant Department Head, Director of the undergraduate program, Graduate admissions coordinator, and Director of the College of Engineering's Video Instructional Program.

In 1987, the McGraw-Hill Book Company published his 730-page textbook, *An Introduction To Circuit Analysis – A Systems Approach*. He has authored numerous scientific papers and chapters.

He is a lifelong amateur astronomer. Some of the author's images of astronomical objects can be viewed at:

http://members.cox.net/dascott2/ImageList.html

Image by the author.

Frontispiece: The Great Orion Nebula, M42 is an emission nebula – a glowing plasma. A quadruple star called the Trapezium is in the exact center of the nebula.

Chapter 1

Introduction

Arevolution is beginning in astronomy and cosmology that will rival the one set off by Copernicus and Galileo. The stream of increasingly bizarre pronouncements coming from astronomers and cosmologists has recently encountered a serious challenge. This challenge is led by a cadre of scientists and engineers, several of whom were Nobel Prize winning pioneers. They are offering simpler, verifiable explanations about the makeup and functioning of the cosmos. Their new ideas, in more ways than one, are ***electrifying*** the discourse in astrophysics.

The defenders of the present cosmological realm are resisting this intrusion into their once exclusive domain. But on-going discoveries about how electric plasma behaves in space are relentlessly forcing dramatic changes in the way we view the universe. The discipline of ***electric plasma physics*** – which until lately has been outside the realm of astronomy – is quickly displacing many of the outmoded theories of traditional cosmology and astrophysics. We now know that cosmic space is full of electricity (electric plasma) and over the last several decades the study of this form of matter has developed into an established body of scientific knowledge.

Questions and Answers

When we were children, most of us looked up in awe at the night sky at one time or another and asked, “What are stars, Daddy? What lights them up?” He might have answered, “They’re little Suns – just like our Sun, but far, far away.”

None of us was told that the stars worked electrically. Everyone knew the stars were not electric lights.

As we grew up, we may have read science books in which astrophysicists declared that stars are continuously burning hydrogen bombs – and that they condensed from spinning clouds of gas and dust. Today they tell us that stars even more massive than our Sun are rotating faster than dentists’ drills. They say that in the cores of galaxies, monstrous invisible black holes suck in

everything around them, even light – but that ‘little black holes’ spit jets of matter back out. And they claim that 96% of the material in the entire universe is invisible. Are these responses any more believable or satisfying than those that Daddy offered us?

Can you make sense out of press releases and TV programs that attempt to explain the newest astronomical ‘discoveries’ – things like invisible dark energy, warped 11-dimensional spaces, and black holes that spit out matter? If not, you have lots of company.

The time to search for some realistic, intelligent, scientific answers has arrived. And those sensible answers are out there for those who are ready to listen.

Image by the author

Figure 1: The Veil Nebula, twisting cosmic plasma located in the summer constellation Cygnus.

Plasma physicists know that 96% of the universe is ***not*** made up of ‘invisible matter’ but rather of matter in the plasma state. Electromagnetic forces between electrical charges are many orders of magnitude stronger than Newton’s gravitational force, and we are finding that deep space is filled with electrical charges and magnetic energy. In fact, using the accepted estimated value of the magnetic field strength in the volume between our Sun and its

nearest stellar neighbor, this field stores an amount of energy that would keep the Sun radiating for about 200 years[1].

Astrophysicists do not study experimental plasma research in graduate school[2]. They rarely take any courses that discuss Maxwell's equations[3] and electromagnetic field theory. Thus they attempt to explain each new discovery using what they do study – gravity, magnetism, and fluid dynamics – the Seventeenth and Eighteenth Century tools of their forefathers, Kepler and Newton. Consequently their methods have not kept up with the science of the Nineteenth Century, let alone the Twenty-First. No wonder they do not understand that many cosmic phenomena are due to forces other than gravity, fluid flow, and the magnetism of lodestones. When questions arise about the failure of their incomplete models, cosmologists often invoke 'new properties' of magnetic fields – properties that magnetism simply does not have, or they propose the existence of unobservable entities and forces. They almost never reexamine their basic assumptions or rethink their hypotheses.

The cosmos in fact does not contain the mysteriously undetectable entities that present astrophysical theories require. Modern, straightforward explanations of all the phenomena astronomers find so enigmatic are now available to us. Anyone interested in astrophysics needs to become aware of the properties of the ***electric plasma*** that fills more than 99% of the universe. Ours really is an Electric Sky.

Alfvén's Warning

In February 1981, eleven years after Swedish electrical engineer Hannes Alfvén won the Nobel Prize in Physics, he published yet another book[4]. This one was called ***Cosmic Plasma***[5]. By disregarding Alfvén's new text, as they had his earlier works, the astrophysics community did not heed his warnings that they were working their way down a dead-end path strewn with errors of understanding. The complicated maze that astrophysics has become in the last few years is a direct result of years of ignoring Alfvén's work and his advice. Hannes Alfvén is the central figure in the emerging electric plasma cosmology.

All our space probes that have been equipped to detect separated

electrical charges – electric plasma – have found it, lots of it. The behavior of these plasma clouds is scalable, that is to say, giant cosmic plasmas behave in much the same way (obey the same physical laws) that small laboratory plasmas do here on Earth. Therefore we are able to create accurate models of cosmic-scale phenomena in the lab and study them.

Technology and Science

People have great confidence in science these days. Recent advances in medicine, communications technology, computers, chemistry, genetics, and information science have made our lives better. We look at the achievements in these fields of human endeavor and acknowledge them with admiration. "These scientists, doctors and engineers ***really*** know what they are doing."

Today most people have cell phones. New surgical procedures, hospital techniques, instrumentation, and medicines are saving, prolonging, and improving the quality of our lives. We have digital devices we can put in our pockets that hold 6000 books, more than most people read in a lifetime. Through GPS receivers we can tell exactly where we are anywhere on the surface of Earth. The latest stock market report is available to us while we are mountain climbing in Asia. We flew to the Moon decades ago and we have sent landers to Venus and Mars. We have orbited Jupiter and Saturn and visited several of their moons. Presently another of our interplanetary probes is on its way to Pluto. Four deep-space probes are now near the outer limits of our Sun's reach – the heliopause. We have orbiting, computer-driven telescopes that can see a thousand times better than the largest earthbound optical observatories of only a few decades ago.

We have put our faith in scientists and engineers, and it has clearly paid off – except in astronomy (and possibly archeology and geology).

Why would we want to single out these fields and cast doubt on their results?

The answer is because there are no tangible, usable products from which we can judge the validity of theories emanating from sciences that deal with events that happened long, long ago, and far, far away. Professional astronomers judge their success by the degree to which other astronomers believe and accept their ideas. They do not produce results that we, the public, can physically evaluate: They just send up rockets, take pictures of

the night sky, write papers, and tell us impressive stories about how it supposedly works and how it supposedly got there. Most of their recent explanations are counterintuitive and almost impossible to understand. This does not mean everything they claim is necessarily wrong, but how can we actually verify what they are telling us?

The same question can be raised about the archeologists: They dig holes around the world, they look at bones and shards, they write papers, and they tell impressive stories about mankind's history. Theoretical geologists also tell impressive stories about how the continents have shifted and how and when the mountains formed.

Both these groups are considered successful if other archeologists and geologists accept their hypotheses. Popularized versions of their theories are published in *Scientific American*, *Discover*, and *National Geographic*. None of these fields (archeology, geological history, and astronomy) is able to produce results that can be tested experimentally. So how can these researchers judge the correctness of their conclusions without considering a *range of possible explanations* that are based on different assumptions?

This book will not specifically address problems in geology or archeology. They are mentioned here only for completeness – to point out that both these branches of science have difficulties similar to astrophysics. There is almost no way to judge the validity of theories that deal exclusively with phenomena that happened long, long ago and far, far away – with things that we cannot directly get our hands on. This is not the fault of the investigators in those areas; it is simply an inherent problem for them. How do they cope with it? This is one of the questions the first few chapters will address.

There is an important difference between science and technology. An old professor of mine, who was Russian, once said to me, "Do you know how they used to test a new bridge in Russia? They put the engineer who designed it ***under*** the bridge, and then they marched the army across it." Astrophysicists do not design anything that we can march the army across. But today, if you are an engineer who designs a bridge that falls down or a cell phone that does not receive a signal, your failures will quickly be embarrassingly obvious to all. The fruits of technology are real and are testable (do they work?). Most of the results of the science of astrophysics are not testable.

We ought to question whether our trust is as well placed in the untestable pronouncements of astrophysicists as it is in the work of the engineers and technicians who give those scientists the tools they use. There is no doubt that the Hubble Space Telescope, the Spitzer infrared orbiting telescope, the Chandra orbiting x-ray observatory, SOHO[6], and the magnificent, new, big, ground-based telescopes are all genuine ***technical*** marvels. The images and data that are retrieved from them are stunning in clarity and precise in detail. They produce real and accurate scientific data. But are the published interpretations and hypotheses that attempt to explain this data as accurate as the tools that provide that data in the first place? We must learn to distinguish between the quality of the ***technical tools*** that are used and the quality of the ***scientific conclusions and theories*** that are being formulated by those who use those tools.

Where We Are Headed

In this book, we will look at many of the theories of present-day astrophysics and compare them to corresponding answers that have arisen from the study of electric plasma. But before we can propose any new alternative cosmology – a Plasma Cosmology to replace the presently 'accepted' astrophysical and cosmological belief structure – we have to examine some of the basic problems inherent in those accepted ideas. Before we buy into any new way of looking at the cosmos, we need to ask, "What's wrong with the old way?" To answer this, we must establish some fundamental guidelines about how a true science discovers knowledge. We must be clear in our own minds how to distinguish between science and pseudoscience. There are basic requirements and inherent limitations involved in the scientific method with which we must be familiar. In fact there is more than one scientific method, and we have to be clear about the differences among them.

When a dentist repairs a cavity in your tooth, the first thing he does is to excise the decay. The first third of this book is similarly devoted to exposing many of the things that are wrong with the present paradigms of astronomy and cosmology. These first six chapters are not intended to be an indiscriminate rant against mainstream science but rather a dispassionate

exposé of some of its real deficiencies. We must take a cold, hard, analytical look at the methods of modern science in general and astrophysics in particular.

The only way we can judge the scientific output of astrophysics is to ask: Is there a better way of looking at the cosmos that answers our questions in a simpler, more straightforward way – one that does not require hypothetical entities and counterintuitive notions? Has the astrophysics field kept up to date with the rest of science? Is it making use of all the modern scientific tools, techniques and data that are available? Is it open to hypotheses that look at old data in new ways? These questions will be explored in the first three chapters.

In order to make informed judgments about how stars can affect each other (or possibly collide), we need to have a sense of how far they are from each other. We need to have an intuitive, conceptual model of how big galaxies are and how far apart they are. This is provided in chapter 4.

A key example of one of the shortcomings of present mainstream astrophysics is that so many things seem to be 'missing.' There is missing matter, invisible dark energy, invisible 'strings,' and too few solar neutrinos. These are discussed in the fifth and sixth chapters.

After detailing these criticisms in the first six chapters, we progress to the main content of this work – a description of the experimentally verified properties of electric plasma, how they pertain to what we see in the sky, and how they avoid the pitfalls we have just examined.

Beginning in chapter 7, with a sequence of scientists and discoveries that have led to our basic understanding of electric plasma, we start to see that the sky is indeed highly electrical in nature. The hypotheses of these plasma scientists on the subjects of solar, stellar, and galactic behavior are careful extrapolations of their demonstrated experimental results and physical principles. They do ***not*** involve invisible matter or unseen forces or 'new science' – claims that the laws of physics must be different out there in deep space (where we cannot falsify them) from what they are here on Earth.

We will then take a close look at some of the obviously electrical properties of our Sun, the solar system, the stars, and our galaxy. The work of Dr. Halton C. Arp on the property of starlight called 'redshift' (and the way his work has been received by the astrophysical community) is so closely entwined with the problems of accepted astrophysical theory that we devote

an entire chapter to it.

Finally, we will attempt to answer the question, “So what?” Why is it important that the average person knows about what is going on now with science in general and with astrophysics in particular? How will it affect me?

It’s Time to Decide

The main thrust of this book is that the time is ripe for informed people from outside astrophysics to demand reasonable answers to reasonable questions and to evaluate what the astrophysical theoreticians have been telling us.

If, as we will claim, the causes of most of the observed phenomena of modern astronomy are electrical in nature, do you need a degree in electrical engineering before you can understand them? Indeed not. The average informed person ***can*** understand and make rational judgments about these ideas. All it requires is the time and patience to read and to think logically and critically about the issues. Some basic facts and a few new concepts will suffice. So the main goal of this work is to convince you, the reader, that you really do have both the capability and responsibility to make informed, critical judgments about the pronouncements of established scientists. A careful reading of these pages will enable you to make an informed assessment of this new plasma-based alternative cosmology.

Interested plasma scientists and electrical engineers have been thrashing out the various hypotheses of Plasma Cosmology in their conferences and publications. So far, most astrophysicists have completely ignored them. Instead of engaging in further futile attempts to persuade the astrophysical community to seriously consider these new ideas, a growing band of plasma scientists, engineers, and a few brave cosmologists and astronomers are simply bypassing them. A paradigm based on electric plasma, which does not find new discoveries to be enigmatic and puzzling but instead to be predictable and consistent, is slowly but surely gaining ground. But it may well be that general acceptance of these new ideas will have to wait until the present occupants of the astrophysics power structure have retired from the scene.

Right now what is needed most is the public’s realization that astrophysics, led by insular theoreticians and not by well-informed, broadly

educated scientists, has stumbled far down that erroneous path predicted by Alfvén.

A cadre of plasma scientists and engineers, who are presently employed in industry, government labs, and universities – but not in most astronomy departments – is quietly working to modernize cosmology. Will this new breed of scientists and engineers,[7] who are waiting in the wings, be called upon to clean things up? Or will the incomprehensible fog of black holes, dark energy, magically unobservable matter, and other fanciful fictions be allowed to continue to shroud our true understanding of the cosmos?

Of course, the stars are not electric lights – at least not in the sense that we know electric lights. But they ***are*** basically electrical in nature, and their observed properties can truly be understood only from an electrical viewpoint. Let us see how.

Chapter 2

Science Rules

What makes a person a scientist? Scientists are distinguishable from artists, poets, musicians, and others in that they use what is known as the scientific method or the empirical method. It is not that inspiration or 'the muse' is not valuable in science, it is – but it is not the starting point of what we call science.

In today's world, many people call themselves scientists. But only those who carefully adhere to the scientific method deserve that title. The scientific method is like a three-legged stool. The legs are: observation, theory, and experiment. Take away any one of those supports, and the stool will fall. Because astrophysicists deal with things that happened far, far away and long, long ago, they cannot perform in situ[8] experiments. So, it is proper for us to ask whether astrophysicists are actually able to employ the full scientific method. And if not – what, if anything, can they do about it?

The Empirical Method

A set of rules defines the scientific method. A true scientist will:

- Observe a phenomenon – carefully record what is detected – gather as much data about it as possible – review what others have observed.
- Seek patterns in the observations – put numbers on the data – fit equations to those numbers – generalize those equations into a word description of the phenomenon. This word description, together with the equations, is called a 'model' or 'hypothesis.'
- Carry out experiments and gather additional independent data to see how well the hypothesis predicts independent future observations and data. This is sometimes called 'closing the loop' on the hypothesis. This step is crucial[9]. If the results of the experiments differ from the results predicted by the hypothesis, then the hypothesis must be modified or rejected. At this point the basic assumptions made in formulating the hypothesis must be carefully reexamined.

• If the hypothesis successfully predicts the results of several experiments, it can be called a theory. If two different theories predict a given phenomenon equally well, the simpler theory is probably the best one. This principle is called Occam's Razor[10].

This constant referring to and testing against experience – observation and experiment – is why this process is called the ***empirical method***.

The Proper Place for Inspiration

Consider for a moment how legitimate hypotheses are formed: We all are familiar with the cartoon character with a light bulb that switches on over his head. There is more to it than that.

Inspiration comes to knowledgeable people (people who have thought about and studied what they have seen – usually for a long time). The most successful leaps in science and engineering are often made by investigators who are well versed ***in two or more areas of study***. The light bulb goes on when they see how those two bodies of knowledge can be connected. They recognize an interrelationship – an opportunity for cross-fertilization – an applicability of parts of one of those areas in the other field – that has not been recognized previously.

Too often the layman thinks he can hypothesize out of thin air. For example, I recently talked at length with a sympathetic friend. He was a well-intentioned fellow who listened patiently to my contention that astrophysicists are ignoring a well-developed part of engineering-science of which they should be aware. He had lots of good advice for me on how to go about presenting my ideas. He then abruptly told me that he had long thought that ***all stars*** might be black holes.

I was taken aback. What evidence did he have for saying this? Had he studied the literature on black holes and normal stars and then recognized a relationship or commonality that others have missed?

Or was it that he had experienced a wholly unsupported revelation? What prompted the idea? Was it just pure inspiration?

He had clearly accepted the notion that black holes are real entities. He then felt that he too could join the hypothesizing game and play 'what if.' What if all stars are black holes? Then … (you can fill in the blanks).

Anyone can say, “What if.” This first – possibly wrong – concept can then serve as the basis for other ‘what ifs.’ A sequence of ‘what if’ hypotheses can be cantilevered onto the first one. Eventually a conglomerate of pseudo-explanatory proposals is built up. Often this is so beguiling that people forget that the fundamental basis of the entire edifice was only a ‘what if?’ – not a verifiable fact.

If astrophysicists can postulate the existence of unseen entities, why couldn’t my friend hypothesize whatever came into his mind?

The answer is: because that’s not science. That’s not the way it works. That is simply unfounded speculation. It may be fun to do. But, it is not the way legitimate scientific hypotheses are formulated.

One cannot propose things for no reason other than “I just thought it up.” It is not legitimate to ‘dream up’ hypotheses out of whole cloth – out of the blue. The proponents of the Electric / Plasma Universe do not do this sort of thing. Many ***reasons*** and ***previous scientific observations and experiments*** serve as the foundation and motivation for each of the hypotheses they are proposing. A decades-old body of experiments and publications supports everything they are saying. That, of course, does not mean every (or any) one of these hypotheses is necessarily correct.

Proof and Disproof

It comes as a surprise to most people that theories can never be ***proved*** – that is impossible to do[11]. No matter how good a theory appears to be, some other still undiscovered mechanism may be the real cause of the observed phenomenon. New data may come in tomorrow that will demolish today’s most well accepted, elegant theory. Therefore, theories can never be proved correct.

However, they can be ***dis***proved if they fail to predict the outcomes of future experiments. Philosopher Karl Popper pointed out that the line between science and pseudoscience lies in the willingness of real scientists to make ***testable*** predictions based on their theories and then to give up those theories if and when they fail any such test. Popper said, “Good tests kill flawed theories; we remain alive to guess again.” A disproved theory is called a ***falsified*** theory.

Huxley[12] called this giving up of a favorite hypothesis "The great tragedy of science – the slaying of a beautiful hypothesis by an ***ugly fact***."

The renowned physicist Richard Feynman said, "It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong." To whatever extent we can, we must go into the laboratory and test our hypotheses.

Most present day scientists give at least lip service to the empirical method. But in the sciences that deal with things that happened far, far away and long, long ago, the ***deductive method*** has crept into use. The deductive method derives theories from assumed generalizations about the universe. This is the method used in mathematics.

When mathematicians (and geometry students) 'derive a proof,' they are developing a sequence of logical steps that leads to a final statement that is consistent with the first statement in the derivation. As an example, if we accept the basic definitions, axioms and postulates of Euclid's geometry,[13] we can 'prove' that 'lines parallel with another line are parallel to each other.' But this is not a proof of the existence of any real-world physical mechanism – it is an exercise in the logical manipulation of a set of basic mathematical axioms. Such manipulations are completely internal to mathematics and remain disassociated from the real world unless and until such an association is demonstrated by observation and experiment.

The Deductive Method

Aristotle (384–322 B.C.) and his teacher Plato (427–347 B.C.) had fundamentally different opinions about how humans acquire knowledge.[14] Aristotle favored the idea that truth lies outside ourselves and can be discovered by using our senses. Our present-day empirical scientific method rests on this same principle – the realization that there is a 'real world' out there. It exists independent of man's hopes, desires, perceptions, or efforts to control it. 'Science' is simply mankind's efforts to understand this 'reality' as best we can.

Plato and others believed that truth and knowledge are to be found within us. They believed that truth is discovered by self-reflection and rational thought. In this process, one starts with a presumed law of nature – an

obviously correct (accepted) generalization about the way things work – and ***deduces*** (works out, derives) its logical consequences.

A hypothesis arrived at via this deductive method is promoted to the status of being a theory when and if a large enough body of experts accepts it. This is an application of the Socratic method, also sometimes called the 'dialectic method[15].' Socrates (469–399 B.C.) believed that truth was discovered through intense conversations with other informed people. In this method, a vote of the experts determines when and if a theory is correct. Once such a theory has been accepted, it is not easily rejected in light of conflicting evidence. It is, however, often modified – made more complicated. When over time a theory becomes officially accepted, the essence of the matter has been settled and fixed. Modifications to the fine points of the theory can then be proposed and debated, but the backbone structure of the theory is set. That framework has already been firmly established.

An inherent flaw lurking in this method is: What if your 'obviously correct,' basic, starting-point presumption is wrong? Roger Bacon correctly pointed out that, "argument is not enough, but experience is,"[16] and also, "Whoever wishes without proof to revel in the truths of things need only know how to neglect experience."

Science places first priority on the empirical method. The deductive method is (should be) secondary – used to derive testable consequences from empirically generated hypotheses. Inverting these priorities makes science into a pseudo-religion. In religions, revelations of 'truth' take precedence over worldly observations of fact.

In those scientific circles where the deductive method reigns supreme, theory takes precedence over empirical facts. Albert Einstein reportedly once said, "If the facts don't fit the theory, change the facts."

Stephen Hawking was frank about his view of the interdependence of reality and theory: "If what we regard as real depends on our theory, how can we make reality the basis of our philosophy? … We cannot distinguish what is real about the universe without a theory.... [I]t makes no sense to ask if it corresponds to reality, because we do not know what reality is independent of a theory." He – and the theoretical physical sciences – apparently failed to notice that the repeated application of the empirical method is how this

interdependence is refined and reality becomes known. This oversight (that places deductive assumptions beyond the reach of testability) has gained theoreticians the stature of priests but at the expense of losing touch with reality.

Contrast this to Hannes Alfvén's comment[17] about the continuing failure of deductive theoreticians to produce controlled nuclear fusion: "They have shown that many of the conclusions which were drawn from classical plasma theory were wrong and once again demonstrated that science is basically empirical. Theory is of value ***only when developed in close contact with reality***." And: "We have to learn again that science without contact with experiments is an enterprise which is likely to go completely astray into imaginary conjecture." Roger Bacon had said[18] much earlier, "Experimental science is also that which alone, as the mistress of the speculative sciences, can discover magnificent truths in the fields of the other sciences, to which these other sciences can in no way attain."

To state it differently: "Reality is that which, when you stop believing in it, doesn't go away."[19] It's just there. Use it – or get over it. Come to grips with it. But, ignore it at your peril. Those who refuse to acknowledge that reality exists, independent of any theory, ought not to sit on railroad tracks.

Peer Review

One mechanism that maintains the primacy of deduced theory over experiment in present-day astrophysics is the peer-review system. Any article submitted to a scientific publication must be reviewed and approved by other scientists working in the field. All research proposals submitted to funding organizations are reviewed and then either accepted or rejected by peer-review committees. Some research labs even have *internal*-review committees to which proposed papers must be submitted prior to their being sent to outside journals – a perfect example of the Socratic method.

It seems reasonable – even essential – that scientific publications and funding agencies not be swamped with 'I just thought it up' ideas. So they have set up a system wherein a scientist's peers first examine and then pass judgment on whether his work ought to be funded and his results published. It sounds eminently reasonable.

But there is a hidden danger in peer review. If experts who have collectively accepted a deduced theory control both the funding of future research and what results get published, their self-interest may lure them to reject competing hypotheses. There may be little chance for any legitimate alternative viewpoints to develop. Reviewers may judge a submission not on its scientific merit but on whether it conforms to the reviewers' beliefs. Because of this conflict of interest, the peer-review system has also been called 'competitor review.' It can take on the atmosphere of an 'old boys' club,' wherein newcomers with new ideas are scrutinized more rigorously than established members.

Peer-review committees are often anonymous. They do not allow the applicant representation or a say in the selection of the jury. This anonymity of review committees can become an irresistible opportunity for reactionaries to censor ***any*** innovative ideas. We put blinders on a horse to keep him on the straight path. That may be good for a horse-drawn cart, but it is bad for science. The answer we are looking for may be in the middle of the field off to the side of the road.

Inertia tends to keep a body or institution moving in the same direction as in the past. An unintended consequence of the peer-review system is that it can keep science permanently locked into the presently accepted paradigm. The selection for publication of only the data that support a presently accepted theory is the likely result of this system. Little if any research that challenges accepted scientific models will get substantial funding – so it will almost never get performed or its results published.

Even more dangerous than the suppression of new ideas that are not supportive of accepted theory is the reflexive ***acceptance*** for publication of pseudoscientific results that ***concur*** with accepted theory.

Hypotheses that are consistent with standard models often pass peer review without anyone seriously questioning whether the idea has been developed using the empirical scientific method. Yet in most cases it is not difficult to check whether the scientific method has actually been properly employed. For example, consider the hypothesis that "There are gnomes in my garden who make themselves invisible when anyone tries to observe them." Clearly, no conceivable experiment or observation exists that could ever falsify that statement. This marks the hypothesis as being pseudoscientific. This example is laughable. But there are others no less

absurd that have been seriously proposed and then generally accepted without receiving the scrutiny they deserve.

Peer review works well in areas such as engineering, chemistry, and applied physics – areas where erroneous ideas are easily falsified experimentally because they quickly result in obvious failures. But in research areas wherein no real world testing of theories is possible, it can completely obstruct progress. It can also prolong the life of accepted but unsound paradigms.

Non-Falsifiable Hypotheses Are Non-Scientific

The acceptance of the primacy of theory over experiment in astrophysics has led reviewers reflexively to accept just about anything that supports established theory. Inevitably this has lured some astrophysicists into publishing statements that ought to be embarrassing for a legitimate scientist. For example, in an old college debating trick one side challenges the other to disprove the existence of something that doesn't exist – "Prove to me there isn't a rhinoceros under this table. It is an invisible, unsmellable rhino, and you can't feel it – it has no mass. But it is THERE. Prove to me it isn't." Such debating tricks should not be used in science.

Obviously it is impossible to falsify a non-falsifiable hypothesis such as this one. Earlier we pointed out that a hallmark of a pseudoscience is that it poses non-falsifiable hypotheses. When this happens, a red flag should go up in our minds. We must reject quickly and forcefully any demand that we falsify a non-falsifiable theory. Non-falsifiable theories are, by definition, not scientific.

Consider the following example:

Dr. John A. Wheeler, emeritus professor of physics at Princeton University and originator of the concept of black holes, said:

> "To me, the formation of a naked singularity [a black hole] is equivalent to jumping across the Gulf of Mexico. I would be willing to bet a million dollars that it can't be done. But I can't prove that it can't be done."

What he is actually saying is – ***YOU*** can't prove that black holes don't exist, so ***I*** am free to use the concept as often as I like.

It is a non-falsifiable hypothesis[20]. It is intellectually dishonest.

Scientists worldwide should have instantly challenged it. It should never have passed peer review.

If you allow me to get away with postulating the existence of non-observable gnomes, then in the future you will have to put up with my blaming gnomes for an increasing number of otherwise inexplicable events – like why I couldn't find my keys this morning. Gnomes hid them. Gnomes would make it easy for me to avoid confronting the reality that my memory is not as good as it once was. And every time I get away with 'the gnome did it' excuse, I am motivated to use it yet again.

One defender of the existence of black holes has said, "A proposal is falsifiable if it has observational consequences, i.e. you determine what it predicts should happen if it were true, and then you look for manifestations of those predictions."

As an example: first, astrophysicists postulate the existence of a type of black hole that emits jets of matter. Next they observe jets coming from an active galaxy. From this they conclude that the observation proves the existence of that type of black hole. This has it backwards: Scientists must look for ***failures*** of predictions. The process of judging one proposal cannot exclude the possibility that another proposal may explain things better.

This is a more elegant way of making the same logical mistake my Irish grandmother does when she tells me that little gnomes come in the night and do strange things. The upturned chair in the garden is inferred proof of their existence. She first postulates that the little people exist, and then she 'predicts' that strange things will be observed. When she sees the upturned chair, she offers this 'observational consequence' as proof that she was right; the gnomes really do exist; she claims she has proved it.

Of course, this is illogical. Inference is not proof. This logical fallacy of 'asserting the consequent[21]' has been known since at least the time of Aristotle. A theory is falsifiable ***only*** if there is some conceivable test to which it can be put such that a negative result would ***dis***prove the theory.

Establishment astrophysics appears no more willing to accept the notion that some other cause (such as electrodynamic effects in plasmas) can produce the observed effects they attribute to black holes than my grandma is ready to accept the idea that a gust of wind or the neighbor's dog upset the

chair.

The Black Hole Epidemic

The practice of invoking the presence of black holes to explain the extremely high-energy outputs observed from certain galaxies has reached epidemic proportions. A recently released Chandra orbiting x-ray observatory image[22] was accompanied by this description:

> "More than 500 X-ray sources are present in this high-energy core sample of the early universe. Most of the sources are *supermassive black holes* located in the centers of galaxies. If the number of *supermassive black holes* seen in this patch of the sky is typical, the total number detectable over the whole sky at this level of sensitivity would be ***300 million***."

Included, too, was the customary admission about being mystified:

> "Seven *mysterious* sources have been detected in the southern Deep Field by Chandra, but not by the Hubble Space Telescope. These sources, which are likely *supermassive black holes*, have also been detected in infrared." [Emphasis added.]

So, the physical presence of the entity (a black hole) that its inventor says he "would be willing to bet a million dollars that it can't be done" [that it doesn't exist] is now being inferred in 300 million different galaxies.

Presently the astrophysics community seems to be so much in need of a non-electrical mechanism to explain galactic energies that they are willing to risk the reputation of their science on a million-to-one shot – and do it 300 million times.

Abstractions Are Not 3-D Objects

There is fundamental confusion in astrophysics between purely abstract ideas and actual objects that exist in three-dimensional space. This confusion is rooted in the abstract deductive nature of present day astrophysics. Earlier we mentioned Wheeler's discovery of a 'singularity' in space. In mathematics, the word singularity has a precise meaning. There are various

types of mathematical singularities, e.g., log-canonical singularities, removable singularities, essential singularities, poles, etc. Each of these describes the anomalous behavior of certain terms in mathematical equations.

The word ‘singularity’ as used by Wheeler in association with his black hole ‘discovery’ is directly hijacked from pure mathematics. Wheeler takes this purely abstract mathematical term and reifies it. The verb ***reify*** describes the action of treating an abstraction as a substantially existing entity – a concrete, material, three-dimensional object. This practice has a potentially grave consequence: it enables the user to quietly tack on another idea – an insidious conceptual package deal – that this once wholly abstract term describing the behavior of a mathematical equation now has become a real object in three-dimensional space that can ***do*** things – such as absorb or expel matter. This is analogous to the puppet Pinocchio thinking not only that he is a real boy but also that he can now upset chairs in the garden. This too is fantasy.

People would have laughed if some theoretician had announced that he had discovered a ‘partial differential equation’ floating around in some distant galaxy or a ‘Lebesgue integral’ at the center of a distant globular cluster. Would it not then be reasonable to ask the ‘discoverer’ what color they were? Derision should have greeted Wheeler’s announcement that he had located the actual presence of a ‘naked singularity‘ in deep space. The peer-review system was culpably silent when this travesty was proposed – the black hole invention was given a free pass because it ***supported*** accepted theory.

We have seen that astrophysicists have been invoking the existence of black holes at an ever-increasing rate. They seem to ‘discover’ them everywhere. They have become encouraged by the world’s passive acceptance of their non-falsifiable ‘the invisible black-hole gnome did it’ explanations. That this enlarging class of fictional forces and particles has long ago crossed the boundary into pseudoscience does not seem to occur to them, to other scientists – or to the public. There seems to be no distinction between the words ‘discover’ or ‘invent’ or ‘fabricate’ as used in astrophysics.

A search of the Astronomy Picture of the Day (APOD)[23] web site archive shows that the astronomers who write the official explanations of those

images invoked the presence of black holes 117 times from October 1995 through December 2002. Over the same period, neutron stars were presented 64 times. The electrodynamic behavior of the plasma that makes up 99% of our universe was not mentioned. Not once.

Chapter 3

Some 'Ugly Facts'

Cosmology Is Untestable

The biggest problem in astrophysics and cosmology is that experiments are usually not possible. More and more data can be accumulated, but we cannot proactively perform experiments as we do in almost every other branch of science. Because the stars are light years away, we cannot hope to be able to go there and perform in situ experiments on them. Until recently, even the planets were beyond our reach – some still are.

Cosmologists are not able to complete all the required steps of the empirical scientific method. It's not their fault that they cannot perform experiments that have the potential to falsify their theories about what is going on in deep space. But we must acknowledge that we cannot close the loop in cosmology. No exacting tests are possible. So if astrophysical hypotheses cannot usually be tested, how can we reject or modify them?

The only possible way out of this dilemma is that astrophysicists and cosmologists, more than those in just about any other branch of science, must be exceedingly careful to examine their presumptions and the validity of their hypotheses in light of any new data. They must welcome all new data and treat it with respect until it is clearly shown to be flawed. Alternative theories – especially those that offer simpler explanations of observed phenomena – should be given a fair hearing. This is not being done. Astrophysicists seem to be unalterably committed to their deductively derived and now firmly enshrined theories. They appear to be more willing to discard data that contradicts these hypotheses (those 'ugly facts' that falsify theories) than to revisit their underlying assumptions.

An Embarrassing Test – And Its Result

When I was an undergraduate college student, my introductory astronomy professor taught that Venus was 'our sister planet.' Venus was thought to be

covered with a benign atmosphere and was probably a ‘Garden of Eden’ on its surface. And we believed her. Why not? It was the conventional theory.

When space probes finally went to Venus, we found that the ‘garden’ was hotter than theorists thought possible. Venus is extremely hot – and hottest of all at its north pole. Its temperature is 894°F (480°C, 737K), which is hotter than the melting points of lead and zinc. Its atmosphere is much denser than expected. When we were finally able to measure argon isotope ratios in the Venusian atmosphere, we found that they are much too young to fit accepted astronomical models of the age of the solar system. In other words, just about everything that astronomers had previously said about Venus was wrong. Observation had contradicted theory. Some ‘ugly facts’ had been discovered.

Far from being a Garden of Eden, Venus’s surface is the closest thing to Hell that we have found so far. But it was only after closing the loop – by actually going there and performing real-time experimental measurements – that we found the truth. And that truth completely falsified the then accepted theory. It was back to the drawing board again for the cosmogonists[24] – however briefly. This was an ideal opportunity to reexamine the accepted model of how the solar system was formed. There were now good reasons for doing so. Astronomers chose instead to devise new hypothetical mechanisms to explain the observation and to save the accepted model.

To explain the unexpectedly high surface temperature of Venus, Carl Sagan, S. I. Rasool, and C. de Bergh proposed what is now called the ‘runaway greenhouse’ effect. Certain gases, primarily water vapor but also carbon dioxide and a few others, transmit sunlight and absorb infrared (heat) energy. Glass has this same property, and scientists once thought it was the cause of heat retention in greenhouses: Supposedly the glass let sunlight in, the plants and soil absorbed it and reradiated it as infrared energy, and the glass prevented the infrared from radiating back into space. By analogy, ‘greenhouse gases’ could trap heat near a planet’s surface. Presumably a sufficient density of such gases could trap more heat than was radiated away, and the surface would get increasingly hotter.

But if sunlight entrapment in a mixture of gases can indeed cause the temperature to rise to 800 or 900 degrees F, then it should be possible to build an actual greenhouse here on Earth, fill it with a gaseous mixture identical to Venus’s atmosphere, and sit back and watch the temperature rise.

This would be a marvelously non-polluting energy source.

This experiment was never undertaken. But experiments did reveal that the actual cause of heat retention in a greenhouse is the glass roof and walls that prevent ***convection*** transfer of heat energy. If radiation is blocked, hot gases will rise. If there is no physical barrier to restrain them, they will rise until radiant losses to space cool them. Venus's atmosphere has no such glass ceiling. Neither does Earth's.

Here was an instance where actual experimental evidence (Venus's extreme heat) threatened long held theories about how the solar system was formed. That evidence should have motivated questions about the basic correctness of those theories. It didn't.

The runaway greenhouse concept was a baseless 'what if' hypothesis. It was an excuse to paper over an unexpected and embarrassing new discovery. It was tossed out to the public despite experimental evidence that such a mechanism could not occur. No peer reviewer objected to the lack of experimental evidence for postulating this new hypothesis. This is a prime example of several of the honored members of the mainstream being given a free pass.

Electric Charge in Space

Another 'ugly' experimental finding that has forced a silent about-face in astrophysics is the discovery of large amounts of electrical charge in space. We have mentioned that just about every time a space probe goes to a new place in the cosmos, astrophysicists have to modify their models. For as far out as our probes have been able to go, they have measured separated electrical charges – electric plasma. For decades, students in astronomy classes have been told by their professors, "There cannot be charge separation in space. Therefore, all proposals of cosmic electrical effects can be safely ignored."

Many astronomy graduate students have heard their professors give the 'teaspoon of salt' lecture. The lecturer takes a teaspoon of salt, holds it up in front of the class, and then asks the students to calculate how much energy it would take to separate one electron from each of the molecules of sodium chloride in the spoon. The answer is horrendously large. "See," cries the professor, "There cannot be charge separation in space. There just isn't

enough energy out there to do it."

But there ***is*** separated charge (plasma) in space. We have observed it. Our space probes have closed the loop on this hypothesis – and found the truth. There ***is*** a vast amount of electrical as well as magnetic energy stored out there. Trying to prove it cannot exist is like trying to prove mathematically that bumblebees cannot fly. Bees ***do fly.*** And there ***is*** separated charge in space. We have measured it.

There have been many instances in the past when the astronomical community has long rejected an idea that they later are forced to accept. After being denigrated, if the validity of the new idea becomes inescapably evident, a few years go by and then we quietly hear: "Well, everyone has known for a long time that this (the new idea) was always true."

Arthur Schopenhauer once said, "All truth passes through three stages: First, it is ridiculed; second, it is violently opposed; and third, it is accepted as self-evident." Perhaps we are entering the second stage: One well-known astrophysicist recently said, "Yes, there is electricity in space, but it doesn't ***do*** anything." The history of astronomy is filled with many more examples of this denigration/adoption syndrome.

We have also measured vast magnetic fields in space. There is no question that magnetic force predominates over gravity – any child can see that. Think about a ball bearing on a table. All of Earth's mass exerts a gravitational pull on the bearing preventing it from floating off into space. Yet the smallest horseshoe magnet in the child's hand easily snatches it away from that gravity. On a cosmic scale as well, magnetic energy density typically exceeds gravitational energy density. For example, in our local galaxy cluster the magnetic field energy density exceeds the gravitational energy density by at least an order of magnitude[25].

When we observe tremendous energies released in deep space (e.g., from an active galactic nucleus), those who do not recognize the existence of the enormous energy levels available in magnetized cosmic plasmas are completely mystified. They then concoct those invisible entities (e.g., strange black holes that emit matter) to explain away the observation. The solution of these enigmas lies in the simple basic fact that ***electromagnetic forces can be repulsive as well as attractive*** – gravity only attracts.

'Probing' the Sun

A prime example of astronomers' inability to carry out experiments and their relying instead on deductive methods is the study of our Sun called helioseismology.[26] Solar astronomers have credited this technique with "opening up the interior of the Sun to ***direct probing***[27] and measurement." What probing? We cannot probe the Sun. All we can do is passively listen to the signals the Sun emits naturally. Astronomers can and do collect new data, but they cannot actively perform experiments on bodies they cannot get to.

Using a term inappropriately – implying an ability or property that has not really been established – is misleading for the public. It is unethical. Scientists must use precise language that describes exactly what they are doing and nothing more.

Performing an experiment entails doing something to the system under study – initiating some action. We then observe whether the result of this action is what our hypothesis predicts should happen. Just passively gathering more data is not the same thing as performing an experiment. And the statement that "we are probing the Sun" is deliberate overreaching. It conveys a perception that astronomers have an ability that they simply do not have.

In most cases where we have developed an ability to go somewhere in space and make measurements, we often find that previously well-accepted ideas are wrong. Venus is fiercely hot. Space is full of electric charge. Earth generates radio-frequency noise that cannot be heard on its surface. There are many more examples. These all demonstrate that bona fide experiments and in situ measurements need to be performed before we elevate a hypothesis to the level of being a theory.

Thought Experiments

What kind of physical experiments led Albert Einstein to proclaim his General Theory of Relativity (GR)? Einstein was a purely theoretical mathematical physicist. He never went near a physics lab. He conducted only 'gedankenexperimenten'– thought experiments – in order to arrive at the GR Theory. This is a perfect example of the deductive method at work. Its use is exceptionally dangerous in an area like cosmology, wherein it is impossible to falsify any theory.

Now that experts accept the GR Theory, any new data (such as

photographs of the astronomical object known as the 'Einstein Cross'[28]) are discussed only within the context of this complicated theory. The images of the four small objects in the Einstein Cross, when looked at only from this viewpoint, are considered to be supporting evidence for the GR Theory. The Theory is used to interpret the data and then the data are used as proof of the Theory – a perfect example of circular reasoning. However, the data could just as well be interpreted as being supportive of a much simpler cosmological theory. Remember what William of Occam said about that. Thought experiments are not valid substitutes for real experiments.

Basic Assumptions of Astrophysics and Cosmology

Someone once said, "For a man with only a hammer, everything looks like a nail." Presently astronomy and cosmology have two big hammers: General Relativity theory and the Big Bang theory. Evidence contradictory to either of these is rejected as being 'obviously flawed' because it contradicts accepted theory.

When newly obtained data seems to falsify a deduced theory, the assumptions underlying the theory should be closely reexamined.

Most of today's accepted astronomy/cosmology theories are based on two demonstrably false premises:

1. Electric fields, currents, and plasma discharges are not important mechanisms in space. Only gravitational and magnetic fields are important.[29]
2. If the light from an object exhibits redshift, the object must be speeding away from us, and its distance from us is directly proportional to that speed. This assumption is the cornerstone of the Big Bang Theory.

Both these presumptions have been and continue to be contradicted by actual observations of the sky. Recent observations tell us that:

1. The universe is highly electrical in nature.
2. Redshift is more a measure of an object's youth than its velocity or distance.

Mathematical Models

Over time, the two major, false assumptions mentioned above have been festooned with elegant, abstract, mathematical equations pertaining to: mass, energy, velocity of light, etc. The solutions derived from these models have led to pronouncements that 96% of the universe must consist of dark energy and dark matter (23% 'Cold Dark Matter' and 73% 'Dark Energy' – an anti-gravitational force[30]) – all of which is invisible, undetectable, and untestable.

These mathematical models also conclude that a Big Bang occurred wherein all the matter in the Universe (presumably including the matter that we cannot see) was created out of nothing, in an instant, precisely 13.7 billion years ago. Regardless of how elegant the mathematics, if the models are based on faulty assumptions, they are worthless.

The proper way to use mathematics in science is to 'curve fit' a previously observed set of data.

A straight line can be passed exactly through two data points; a second order (quadratic) curve can be exactly passed through any three data points ... and so on. An n^{th} order equation can be made to pass exactly through n+1 data points. Thus, if we have a sufficiently complicated equation with enough coefficients to adjust and arbitrary terms that we can choose (after seeing new data), we can accommodate just about any new observation. The principle of Occam's Razor tells us that the simplest (lowest order) equation – or simplest model – that best fits the data is probably the one that should be chosen.

If every time new data comes along we have to add complexity to our model in order to accommodate it, this should be a hint that the model is fundamentally a failure. It becomes a blob of 'silly putty' that is malleable enough to fit any new data. This sort of model is not a proper basis for a hypothesis; it is merely a blank check to claim we understand something when we really do not. John von Neumann cautioned against rushing to overly mathematical descriptions of things: "There's no sense in being precise when you don't even know what you're talking about."

The essential goal in science is: Can we find a reasonably simple model such that every time new data arrives, the model is comfortable with it without having to vary the coefficients, modify the structure of our equations or invent hypothetical entities to accommodate it? That robust kind of model constitutes a legitimate basis for a hypothesis. But even then we must remind ourselves that models are not reality. Lord William Thompson Kelvin (1824-

1907) correctly said, “Nothing can be more fatal to progress than a too confident reliance on mathematical symbols, for the student is only too apt to take the easier course, and consider the ***formula*** not the ***fact*** as the physical reality.”

Suppose, in some area of scientific investigation, we arrive at a simple mathematical model that seems robust. It apparently fits each set of newly arriving data reasonably well without fiddling with its parameters. It slowly gains acceptance. It survives several experimental tests. But, a crucial caveat still needs to be made, even at this point: An equation is only a ***model*** of the real world process. The variables in the equations are our best ***approximations*** of reality, not reality itself.

We should never lose sight of this distinction. Some modern theoreticians confuse these two things: ***reality*** and their mathematical ***models*** of reality. For them, the equations and the variables that are included in those mathematical expressions are indistinguishable from reality. So, for example, if an equation contains a ‘singularity‘ (yields an infinitely large output value for some finite value of the input variables) they presume the actual real world quantity must also become infinite. This is where the notion of black holes came from.

Electrical engineers are used to dealing with singularities. They use equations that contain complex variables to analyze circuits and systems. Most often these equations contain the type of singularity known as ‘poles’ – there are certain values of the input variables that force the output values of the equations to become unboundedly large, to ‘go to infinity’. It is well known that in the real world the actual voltage or current or whatever the modeled output quantity is does not go to infinity – does not blow up.

There are well-known ways of interpreting singularities. The locations of the poles of a transfer function are informative about how the circuit will respond to other future inputs. Actual ***quantities*** that exist in nature are quite distinct from the mathematical ***variables*** in the equations that attempt to model the behavior of these quantities. The two must not be confused.

Paul Marmet of the Hertzberg Institute of Astrophysics and retired physics professor at the University of Ottawa wrote, “Physicists believe that the most fundamental nature of physics is nothing but equations.” Cosmologist Robert Oldershaw (in the *New Scientist* 1990) wrote, “Theory is fast outracing experimental observations… [A] hypothesis can come to be

regarded as being so convincing and elegant that it simply has to be right."

This is the attitude that astrophysics has adopted: If the output variable of an equation becomes unboundedly large, then the corresponding real world quantity must blow up too. Sometimes they simply ignore these singularities by 'renormalizing' their models. But astrophysicists generally have the attitude, "Let's not worry about the fact that we cannot perform experiments because pure advanced mathematics will provide a way to discover how the cosmos works." Some theoreticians have said that if only they could find the 'equations God used to make the universe,' all would be known. They seek a mathematical 'divine blueprint for the universe.' This demonstrates just how far from the proper use of mathematics they have strayed.

Back to the Drawing Board

We often read in news reports that astronomers are incessantly 'surprised' by new data from space probes and orbiting telescopes. New information invariably sends theoretical astrophysicists 'back to the drawing board.' In light of this, their unshakable faith in the infallibility of their abstract models is curious. Those models seem to require patching up almost every time a space probe sends back a new observation. This continual 'amazement' at new data is a tip-off that something is fundamentally wrong with the basic assumptions of today's accepted astrophysical theories.

Domains of Validity

Another limitation on any mathematical model (set of equations) is that it has a finite ***domain of validity***. For instance, if a given model is developed using a set of input variables whose values ranged from zero to 100, then we cannot use an input value of 1,000,000 and expect the answer produced by the model to have any correspondence with reality.

An example of this involves the design equations that describe the motion of an experimental jet aircraft. Suppose engineers developed these equations assuming the plane's engines would be capable of delivering a thrust of anywhere between zero and ten thousand pounds. What would happen if someone then uses these same equations to predict how the plane would perform if the engines were replaced by a rocket propulsion system capable

of a one-million-pound thrust? It is highly unlikely that the mathematical results will be accurate. It is imprudent to work as a test pilot for an aircraft company that does this sort of thing.

Another example is the similar misuse of Newton's law of gravity. It seems to work properly in describing the motions of falling bodies here on Earth. It precisely describes the requirements of placing satellites into orbit. It is useful in what we call the macroscopic domain of human endeavor.

When we get inside the nucleus of the atom, however, we find Newtonian mechanics to be hopelessly overpowered by what are called the strong and weak nuclear forces. Gravity doesn't seem to work in that sub-microscopic domain. And, in turn, the strong and weak nuclear forces can be safely ignored in the macroscopic domain. They, too, have a limited domain of validity.

Newton vs. Maxwell

The physical laws of electromagnetism have a wider domain of validity than does Newton's law of gravity. The science of electromagnetic plasmas is useful when we are discussing the properties and interactions of laboratory plasmas here on Earth. It also successfully predicts the shapes and the rotational behavior of the galaxies.

Newton's law of gravity fails to explain the way galaxies rotate because that phenomenon is outside its domain of validity. The macro-macro domain in which the galaxies reside is well described by the Maxwell-Lorentz equations, not Newton's.

Some day, perhaps we will discover a Grand Unifying Theory (GUT) that is valid in all domains. We do not have it yet. Until then, we will have to be content in knowing that certain physical laws are valid (useful) in certain size domains – no single one is valid in all size domains. Trying to force-fit Newton's equation into a domain where it does not apply is a primary reason for most of the present difficulties experienced by astrophysics.

Big Bang

Georges Lemaître (1894-1966) invented the concept of the Big Bang. He did not hesitate to include the hand of God in his physical reasoning.

Lemaître was a Roman Catholic priest who earned his Ph.D. at the Massachusetts Institute of Technology and was a professor of astrophysics at the University of Louvain. His theoretical ideas concerning the origin of the Universe were published in 1927, but the paper was largely unnoticed until Arthur Eddington (1882-1944) called attention to it.

Lemaître felt, “Who else could have created something out of nothing but God?”

Alfvén commented on Lemaître’s proposal: “The appeal of the Big Bang has been more ideological than scientific. When men think about the universe, there is always a conflict between the mythical approach and the empirical scientific approach. In myth, one tries to deduce how the gods must have created the world – what perfect principles must have been used.”

It is not the purpose of this book to denigrate the Almighty. We simply contend that we do not need a spiritual argument to explain the sky. It’s not that supernatural. The real cosmos is not invisible, immeasurable, or unknowable. We simply must use our eyes, our brains, and the work product of the last hundred years of serious electrical science. If we do so, we shall see through the mystifying fog.

Inventions in the Mist

The requirements of the non-electrical models of modern cosmology have led to such arcane inventions as: ‘curved space,’ ‘neutron stars,’ ‘weakly interacting massive particles (WIMPs),’ ‘massive compact halo objects (MACHOs),’ several different sizes of ‘black holes,‘ ‘superluminal[31] jets,’ ‘dark energy,‘ ‘strange matter,‘ and magnetic field ‘lines’ that ‘tangle-up,’ ‘merge,’ ‘open,’ and ‘reconnect.’

We continually hear about ‘discoveries’ such as:

- “There is a black hole at the center of that galaxy.” (Otherwise we cannot explain its level of energy output.)
- “There is invisible dark matter in that galaxy.” (Otherwise we cannot explain how it rotates the way it does.)
- “Ninety six percent of the universe is made up of dark energy and dark matter that we cannot see.” (Otherwise clusters of galaxies would

fly apart because gravity alone can't hold them together.)

- "Pulsars are made up of strange matter." (Otherwise we can't explain their oscillator-like behavior.)
- "Photographs of connections between two objects that have different redshifts (such as galaxy NGC 4319 and its companion, Markarian 205) are only chance alignments." (Otherwise the Big Bang is falsified.)

So astrophysicists tell us not to believe in the existence of things that we can observe but to ***believe in*** the existence of their invisible and untestable entities – for the simple reason that their deduced hypotheses require these fictions.

Heresy Is Not Tolerated

A kind of fortress mentality has developed in astrophysics. For example, when confronted by observational evidence such as astronomer Halton Arp's photographs[32] that contradict the Big Bang Theory, the established astronomical community denied him further access to any major telescope in the U.S. They did not investigate his challenging results; they simply rejected his 'ugly' evidence. He now finds it difficult to publish his work in American refereed journals.

The example of what happens to a heretic like Arp when he challenges the party line is a warning to others not to try it. Anyone who suggests that presently accepted astrophysical methods and models ought to be re-examined is discredited and shunned.

The matter is well described by Pulitzer Prize-winning historian Daniel J. Boorstin (1914-2004): "The greatest obstacle to discovery is not ignorance – it is the illusion of knowledge." It seems astrophysics is becoming less of a science and more of an enshrined illusion. It may be allowable for a religion to ostracize heretics. This is not, however, the way a true science ought to be conducted.

Credit: NASA/Mariner

Plate 1: The surface of Venus. The temperature here is 894°F (480°C, 737K), which is hotter than the melting point of both lead and zinc. The mountain tops are reflective in this radar image. Plasma discharges surrounding these highest surface elevations may be responsible for this effect.

Chapter 4

How Big Is the Space Around Us?

In order to understand even the most basic concepts in astronomy, we have to appreciate how immense the cosmos really is. We admire the endless firmament of stars above our heads on a dark winter's night. But do we understand how incredibly remote even the closest stars are from us? How far is the Milky Way? How far away is that magnificent evening star?

Think of our Sun and the nearest star to it. Think of them as being simulated by a pair of golf balls. How far away from each other would we have to place these two golf balls in order to model the separation of these two stars relative to their diameters? What would you guess? 100 yards? A mile? 10 miles?

Modern astrophysicists claim that the only mechanisms capable of forming and driving the galaxies that make up the universe are gravitational and magnetic fields. In order to judge whether this or any alternative explanation is reasonable, we have to be able to visualize the relative sizes of stars and the distances between them.

We need to get a sense of the relative density of stars and nebulae as compared to the density of the electrically charged particles that we now know permeate the cosmos.

If we are to do this, we need a scale model that humans can relate to. It is difficult if not impossible for us to relate conceptually to how far something is from us when we are told its distance is, say, 14 light years. We know that is far away – but ***how*** far?

In his classic three-volume *Celestial Handbook,*[33] Robert Burnham, Jr. presents a model that offers us a way to get a conceptual grasp on some of the tremendous distances discussed in astronomy. His model is based on the coincidental fact that the number of inches in a statute mile (63,360) is approximately equal to the number of Astronomical Units in one light-year (63,294). (The distance from the Sun to Earth is called an Astronomical Unit (AU). It is approximately 93 million miles.) So think of laying out the distance of one mile and marking it off in inches. If we could similarly lay out the distance of one light-year in intervals of AUs, it would contain about

the same number of divisions. This defines our scale model:

- One mile in the model represents a light-year.
- One inch in the model represents the distance from the Sun to Earth.

In our model we can sketch the orbit of Earth around the Sun as a circle having a one-inch radius.

In reality, the Sun is approximately 880,000 miles in diameter. In the model, that scales down to 880,000 / 93,000,000 = 0.009 inches – approximately 1/100 of an inch in diameter. Mark a dot on a piece of paper. You will need a very sharp pencil point to make a small enough dot to represent the Sun at the center of the one-inch radius circle that shows Earth's orbit.

In this model, Pluto is an invisibly small speck approximately three and a half feet from the Sun – so we need a good-sized sheet of paper. If a man is quite tall, he may just be able to spread his hands far enough apart to encompass the orbit of this outer planet. All the other planets follow almost circular paths inside of this 7-foot diameter orbit that Pluto follows. Their radial distances from the central Sun are: Mercury 0.4"; Venus 0.7"; Mars 1.6"; Jupiter 5.2"; Saturn 9.5"; Uranus 19.2"; Neptune 30"; Pluto 39.5". That is the size of our model of the solar system. We can just about hold it in our outstretched arms.

The nearest star to us is over four light-years away. In Burnham's model, a light-year scales down to one mile. So the nearest star to us is four and a half miles away. Thus, when we use this scale model, our Sun and the nearest star to us become two specks of dust, each 1/100-inch in diameter, separated by a distance of four and a half miles. And this is in a moderately densely packed arm of our galaxy.

That bears repeating: Our Sun and its nearest neighboring star are like ***two pieces of dust that are more than four miles away from each other.***

To quote Burnham, "All the stars are, on the average, as far from each other as the nearest ones are from us. Imagine, then, several hundred billion stars scattered throughout space, each one another Sun, each one separated from its nearest neighbor by a distance of several light years (several miles in our model). Comprehend, if you can, the almost *terrifying isolation* of any one star in space" because each star is the size of a speck of dust, about 1/100-inch in diameter – and it is *miles* from its nearest neighbor.

When viewing a photographic image of a galaxy or globular star cluster, the stars appear much closer together than this scale indicates. The light from a star will ‘bloom’ on a photographic plate or digital camera, producing an image that appears much larger than it actually is. Sometimes they do look a bit like golf-balls. They are not. Always remember the two specks of dust, miles apart. The answer to the question that we asked about how far apart two golf balls would have to be in order to model these same two stars is – over 700 miles.

In Burnham’s model, the collection of stars that makes up our Milky Way galaxy is about one hundred thousand miles in diameter. It would be surrounded by many hundreds of thousands of miles of empty space before we would get to the next galaxy. Galaxies seem to be found in groups – galaxy strings and clusters – with still greater distances between the clusters. Even our model fails to give us an intuitive feeling for the vastness of those great distances.

Because stars are so tiny relative to their separations, they have only a minuscule gravitational pull on each other. But because the spaces between stars are permeated with plasma, electromagnetic effects are great. We now know that the entire volume of our galaxy is filled with magnetized plasma – far-reaching diffuse clouds of ionized particles. These electrically charged particles are not far from each other relative to the strength of the interacting forces they exert on each other. That force can be up to 39 powers of 10 stronger than gravity. (See footnote p. 46.) It is becoming clear that galaxies are not formed or held together by gravity but by electromagnetic forces. We will consider this in detail in a later chapter.

As an application of the insight afforded by Burnham’s model, let us consider the oft-proclaimed phenomenon known as gravitational lensing. If a far distant object lines up precisely with Earth and a mid-distance object that has enough mass, then Einstein’s theory of General Relativity predicts that the light from the farther object will be bent – producing two symmetrically placed images of that distant object when it is observed from Earth. Gravitational lensing is now a customary explanation used by astronomers to discredit any observations of quasar pairs situated very near their parent galaxies. We are told that any images of this sort are ‘mirages’ due to gravitational lensing. Once this explanation is accepted, the way is cleared for its continued use, no matter how improbable its repeated occurrence is.

Another name for gravitational lensing is ‘microlensing‘. Astronomer Dr. Paul Vreeswijk at the Rijksuniversiteit Groningen, in the Netherlands has summarized the present state of this concept[34]:

> In the past few years a huge number of papers about microlensing have appeared. Because of this, the subject of microlensing may seem to be a very new area of astronomy, but in fact the idea is rather old. In 1936 Albert Einstein himself published a one-page paper in *Science* regarding microlensing. For him it was more or less a Gedankenexperiment: observe a certain star A on the sky and imagine another star B in the line of sight toward A. What will happen to the light coming from A? He showed that when A, B and the observer are exactly aligned, a ring-like image will be formed. When B is some small distance away from the line of sight, two images of A will be created. However, the angular separation between these images, or the diameter of the ring, is of the order of milliarcseconds and cannot be resolved. What can be seen is the enhanced brightness of A, since the sum of the luminosity of the two images (or ring) is larger than the unamplified luminosity of the star itself.
>
> Light from star A that would have missed the earth without star B in between, is now bent by B toward the observer. Star B acts as a gravitational lens, and the effect is called microlensing. In practice the chance of observing two stars aligned within one hundredth of an arc-second with the earth is very small, since the volume density of visible stars in the Galaxy is so small.

Credit: NASA and STScI

Figure 2: The Einstein Cross

Possibly because of this infinitesi-mally small probability of occurrence, present day astronomers have turned their attention to gravitational lensing by entire ***galaxies*** rather than single stars. They claim that widely separated multi-ple images of single background objects (hidden behind those galaxies) can and do occur. But that would require that the entire mass of the galaxy act as if it were concentrated in a single point – and that single point has to be exactly in line between Earth and the far distant object. But the observations of the movement of stars in galaxies indicate that the total mass does ***not*** act as if it were concentrated at a single point.

The image of the 'Einstein Cross' as released by NASA is shown in figure 2. We are told that the four small quasar-like objects surrounding the central bright core of the galaxy represent a single quasar located in the far distance directly behind the center of the galaxy. Supposedly we are not seeing separate quasars but only four 'mirages' caused by microlensing. The proof astronomers offer for their conclusion that the four small quasar images are in the deep background is that they have a vastly greater redshift value than does the central galaxy. Note, however, that Vreeswijk points out that only ***two*** images of the distant object should result from microlensing, not four. Four images would require *four* objects (*two* distant quasars, the galaxy, and Earth) to be almost precisely aligned.

Spectral analysis of the region between the quasars in the Einstein Cross and the galactic core indicates that they are connected to the galaxy by streams of hydrogen gas (plasma). This plasma has the same extremely high redshift value as do the quasars. So, what we actually have are four young quasars symmetrically positioned around and physically connected to the active nucleus of a barred spiral galaxy. There is no mirage. No relativistic gravitational magic is needed to explain what we see happening in front of our eyes.

But what is most important, as pointed out by Vreeswijk, is the statistical improbability of this suggested, precise, four-object lineup happening in the first place, let alone over and over again. We ought to examine the question of how probable (or improbable) the occurrence of this phenomenon really is.

Astronomers recently announced they were going to look for microlensing effects that might be occurring in the closely packed globular

cluster M22.[35] For such a gravitational lensing effect to be visible on Earth, (any) two stars in the cluster and Earth must line up – all three objects – on the same exact straight line. Using Burnham's model to visualize the relative diameters and separation distances of stars (about 2.4 light-years) we can calculate the probability of this lineup actually happening. Each star in the model of the cluster is the proverbial dust mote and is separated from its nearest neighbor by 2.4 miles. The computation yields an overall approximate probability of 10^{-7}, ***one in ten million***. This result is, of course, only an approximation. But it does reveal the futility of looking for actual gravitational lensing in M22. The following question must, in all seriousness, be asked: How much research time and funding should reasonably be expended in looking for a phenomenon that we have an *a priori* one chance in ten million of observing?

This means that if astronomers see anything 'mysterious' in M22, they cannot with any credibility point to 'gravitational lensing' as being the cause. And if this is so obviously true in a dense cluster like M22, gravitational lensing is even less likely when discussing galaxies in general and supposedly far distant quasars – like those allegedly in the Einstein Cross.

Although astrophysicists do not invoke the occurrence of microlensing as often as they do black holes and neutron stars, we do see them falling back on this proposed mechanism as an explanation of otherwise enigmatic observations more and more often. Again, once accepted, its repeated use becomes attractively feasible.

It is also often suggested that individual stars collide with other stars (or galaxies with other galaxies). This rationale is used as a possible cause of all sorts of otherwise inexplicable observations. Burnham's model offers us the insight needed to analyze suggestions of this sort as well.

A simple way to estimate the probability of stellar collisions is to consider the following experiment: Choose a densely packed cluster of stars such as the well-known Omega Centauri globular cluster. Shoot a star from outside the cluster directly toward its center and calculate the probability that the star will go straight through without hitting any other star. This is actually an unrealistically tough test, because the stars in any actual cluster are not generally heading toward the center (the cluster is not collapsing).

Using Burnham's model, we can calculate that the probability of our

shooting star hitting a member of the cluster is $1000 / 4x10^{11} = 2.5x10^{-9}$ or one chance in 400 million.

In other words, we could fire stars the size of the Sun toward the center of Omega Centauri a couple of hundred million times before having a 50 - 50 chance of a collision. And stars do not usually zip like projectiles through groupings of other stars. Stars generally float in the intragalactic plasma sea that surrounds them.

I was once criticized for saying that stars ‘float’ in their positions within the galaxy. The criticism came from a strong advocate of the idea that collisions between stars were happening all over the galaxy all the time. He claimed I should say that stars are ‘zipping around’ in the galaxy.

The most commonly quoted value for the basic solar motion is a velocity of approximately 12 mi/sec. This may be quite different from the velocity of any other given star, but should be ‘in the ballpark’ for most stars in our neighborhood. It gives us a relative feeling for the velocity of typical stars in our arm of our galaxy. This reported velocity is equivalent to 4 astronomical units (AU) per year. So a star traveling with the same speed as our Sun moves about 4 inches a year inside the empty cube (528 feet on an edge) that models the spacing between stars in the Omega Centauri globular cluster. Now some may call this ‘zipping’ around. For something traveling at a rate of 4 inches per year, I think the term ‘floating’ gives a better sense of its motion.

Burnham’s model gives us a sense of proportion about relative sizes of stars, their speeds and their separation distances. Together with some elementary probability calculations, it enables us to be confidently critical of the ongoing barrage of claims about colliding stars, cannibalizing galaxies and microlensed quasar images. The stars that make up galaxies are extraordinarily widely separated and sparse.

Both microlensing and collisions among stars and galaxies are mechanisms that are not impossible. But as explanations for all sorts of observations, they are being invoked unrealistically often. The excuse is being overworked – if not stretched beyond the breaking point of belief.

Chapter 5

The Case of the Missing Matter

Many classic detective stories have titles that begin with “The Case of the Missing….” Before the last page of the book, the clever hero always finds whatever it was that had gone missing and ingeniously explains the reason why. Where are Sherlock or Nick Charles now when we need them most?

Dutch astronomer Jan Oort first discovered the ‘missing matter‘ problem in the 1930s. By observing the ‘Doppler redshift’ values of stars moving near the plane of our galaxy, Oort assumed he could calculate how fast the stars were moving. Since the galaxy was not flying apart, he reasoned that there must be enough matter inside the galaxy that its central gravitational force would be strong enough to keep the stars from escaping, just as the Sun’s gravitational pull keeps its planets in their nearly circular orbits. But when he made the calculation, he found that there was not enough mass inside our galaxy. And the discrepancy was not small; the galaxy had to be at least twice as massive as the sum of the mass of all its visible components. Where was all this ‘missing matter’?

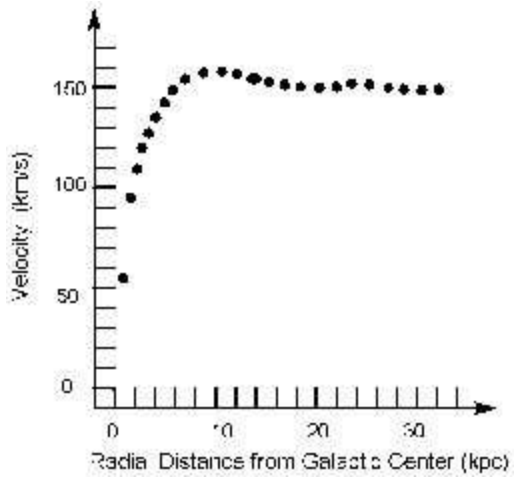


Figure 3: A star’s tangential velocity as a function of its distance from the center of a typical spiral galaxy.

In addition, in the 1960s, new instruments enabled astronomers to measure the velocities of stars in other galaxies. The tangential velocity of those stars

in their orbits around these other galaxies could be plotted relative to their distances from the centers. Such plots are called ‘radial profiles of stellar velocity’ or simply ‘rotation curves.’ If most of the mass of a system is concentrated at the center, as is the case with our solar system, then the farther out an object is the slower it travels in its orbit. This is a basic property of Newton’s Law of Gravitation. However, in the case of galaxies, except for stars near the center, all the stars travel with almost the same velocity, as shown in figure 3.

For a star’s tangential velocity to remain constant as its distance from the center of its galaxy increases, the total accumulated mass of all the stars closer than it to the galactic center must increase proportionally to its radius.

But we can see that stars become sparser with distance in the galaxy. Therefore the included mass will ***not*** increase proportionally with distance. There are only a few additional stars as we approach the outer edge of the galaxy. Either some mass is missing in the outer (‘halo’) regions of galaxies or the outer stars rotating around galaxy cores do not obey Newton’s law of gravity. Of course, since the late 1600s astronomers have assumed that Newton’s gravity is the ***only*** force operating in the cosmos – and therein lies the rub.

Image by the author – Botanical Gardens, Melbourne, Australia.

Figure 4: The application of centripetal force.

There were problems, too, at a larger scale. In 1933 astronomer Fritz Zwicky had announced that, when he measured the individual velocities of a large group of gal-axies known as the Coma Cluster, he found that all the galaxies he measured were moving so rapidly relative to one another that the cluster should have come apart long ago. The visible mass of the galaxies making up the cluster was far too little to produce enough gravitational centripetal force

to hold the cluster together.

Both our own galaxy and the whole Coma cluster were missing mass. Zwicky had an inspiration: Perhaps the missing mass was in the form of bodies that didn't give off or reflect enough light for us to see them. He coined the term 'Dark Matter.' Using Newton's Law, astronomers could calculate how much Dark Matter would be required to produce the observed motions. They developed additional hypotheses about the likely properties of the Dark Matter.

Meanwhile an entirely separate problem arose. Cosmologists who had embraced the Big Bang Theory discovered that there was not enough gravitational energy in the cosmos to satisfy the requirements imposed by Einstein's Relativity Theory. So this too suggested that something was missing. Cosmologists invented another hypothetical force to satisfy the requirements of their theory. This one was dubbed 'Dark Energy.'[36] If one assumed that the theoreticians were correct in their assumption that gravity was the only force that held the universe together, a great deal of it seemed to be missing. In fact, to satisfy theoretical requirements, 96% of the universe had to be made up of these hypothetical entities.

Why this conundrum did not spur a reexamination of the Big Bang concept or of General Relativity is not clear. But let us concentrate simply on the missing mass problem posed by the fact that galaxies do not rotate the way Newtonian dynamics says they must.

At first, astrophysicists decided to leave Newton's laws inviolate and to postulate the existence of some specific invisible, immeasurable, dark objects to make up for the missing mass. They announced the 'discovery' of Massive Compact Halo Objects (MACHOs). It was, of course, an undetectable entity. (Remember the invisible gnomes in the garden?) Here was a case where astrophysicists assumed the truth of the first inspiration and devoted their efforts to inventing more entities that are hypothetical to 'save the assumptions.'

To quote *Astronomy*[37] magazine:

> [A]stronomers have gone to great lengths to affectionately name, define, and categorize this zoo of invisible stuff called dark matter. There are the MAssive Compact Halo Objects (MACHOs) – things like ... black holes, and neutron stars that purportedly populate the

> outer reaches of galaxies like the Milky Way. Then there are the Weakly Interacting Massive Particles (WIMPs), which possess mass, yet don't interact with ordinary matter … because they are composed of something entirely foreign and unknown. Dark matter even comes in two flavors, hot (HDM) and cold (CDM)....
>
> And all the while astronomers and physicists have refined their dark matter theories without ever getting their hands on a single piece of it. But where is all of this dark matter? The truth is that after more than 30 years of looking for it, there is still no definitive proof that WIMPs exist or that MACHOs will ever make up more than five percent of the total reserve of missing dark stuff.

Hot Dark Matter is postulated to be fast moving particles floating throughout the universe: tachyons, neutrinos, etc. Cold dark matter is supposedly to be found in dead stars, planets, brown dwarfs ('failed stars') etc.

Jeremiah P. Ostriker and Paul Steinhardt[38] listed several sub-classifications of dark matter:

1. Cold collisionless dark matter (CCDM)
2. Strongly self-interacting dark matter (SIDM)
3. Warm dark matter (WDM)
4. Repulsive dark matter (RDM)
5. Self annihilating dark matter (SADM)
6. Fuzzy dark matter (FDM)

Eventually the suggestion that 96% of the matter in the universe was invisible began to be worrisome. Even such an august authority as Princeton University cosmologist Jim Peebles admitted,[39] "It's an embarrassment that the dominant forms of matter in the universe are hypothetical...." I suggest that these dominant forms are in the category of particle known as Fabricated Ad hoc Inventions Repeatedly Invoked in Efforts to Defend Untenable Scientific Theories (FAIRIE DUST).

When august authority speaks, the field takes notice. So a second alternative, untenable as it is, was chosen by some embarrassed astrophysicists and called 'MOdified Newtonian Dynamics' (MOND). This paradigm-shaking proposal to alter Newton's Law of Gravity – because it

does not seem to give correct answers in the outer low-density regions of galaxies – was first put forward in 1983 by astrophysicist Mordechai Milgrom at the Weizman Institute of Science in Israel. It has recently been given more publicity by University of Maryland astronomer Stacy McGaugh. Milgrom himself has recently said ("Does Dark Matter Really Exist?" *Scientific American*, Aug. 2002, p. 42-52.): "Although people are right to be skeptical about MOND, until definitive evidence arrives for dark matter or for one of its alternatives, we should keep our minds open."

So the faint rumbling sounds of discord are becoming a bit louder even within the established astrophysics–cosmological community. These rumbles have to do not only with the observed anomalous rotation of galaxies but also with problems in Einsteinian cosmology. In a recent newspaper article ("What Is Gravity, Really?" – *The New York Times in America*), Dennis Overbye writes:

> According to what has recently become a highly celebrated 'standard model,' ordinary atoms make up only 5 percent of the 'stuff' of the cosmos. Some kind of mysterious dark matter, perhaps consisting of elementary particles left over from the Big Bang, makes up 25 percent, while the rest – a whopping 70 percent – consists of something even more mysterious, known as 'dark energy.'
>
> It seems fair to conclude that a cosmology that leaves 95 percent of the universe unexplained is less than a complete triumph.
>
> As a result of all this, physics literature has become peppered with suggestions of ways to change gravity. Given a choice of explanations for dark energy during a cosmology workshop at the Kavli Institute for Theoretical Physics in Santa Barbara, California, 20 of the 44 participants voted for some variation of "Einstein was wrong."
>
> Some of these proposals take their cue from the science-fiction-sounding String Theory, the putative theory of everything, which holds out the possibility that our universe might be a 4-dimensional membrane (or 'brane') in an 11-dimensional space.

It is not encouraging to see that kind of response. When difficulties with present theory become obvious, a reexamination of the basic assumptions of that theory is called for. But instead cosmologists reflexively dive deeper into their morass of abstract mathematics (i.e., membranes in 11-dimensional

space). String theorists assume that everything in the cosmos is the result of the vibrations of submicroscopic entities they call 'strings.' These hypothetical entities are, of course, invisible, and thus, by their proclaimed nature, they are impossible to disprove.

The article goes on to say:

> Also in a stringy vein is Cardassian expansion, named after the villainous race on "Star Trek," and dreamed up by Dr. Katherine Freese[40] and Dr. Matthew Lewis of the University of Michigan. According to their theory, the universe accelerates as a result of other branes tugging on our own. "One can get an accelerating universe without having any dark energy," Dr. Freese said. Other theorists are going back and modifying general relativity directly, noting that when he wrote it down, Einstein chose the simplest possible equations that would carry out his ideas. But ***more complicated equations might be necessary.*** [Emphasis added.]

In another article, entitled "Tangled Up In Strings," that appears on page 16 of the January 2006 issue of *Astronomy* magazine, author Bob Berman states:

> String Theory won't work in our reality of three dimensions plus the fourth dimension of time. To make it work, its creators had to invent six or seven additional dimensions, which contradict our own senses and the rest of science. None of these extra dimensions can possibly be tested. String Theory's only prediction (about the strength of the cosmological constant) proved to be incorrect by 55 orders of magnitude.... That's like predicting mice are larger than stars. We might wonder why universities and the media would play with strings for so long. Why would grownups invest time with untestable concepts that, after two decades, have yet to yield fruit? The partial answer is that these are brilliant people who are having a blast and getting lots of attention.... String theorists have managed to concoct dimensions, argue that no testing is possible, and yet somehow enjoy funding year after year.

In an essay entitled "Einstein Has Left the Building[41]," John Horgan commented similarly on the present state of theoretical physics.

> For the first half of the last century, physics yielded not only deep insights into nature – which resonated with the disorienting work of creative visionaries like Picasso, Joyce and Freud – but also history-jolting technologies like the atomic bomb, nuclear power, radar, lasers, transistors and all the gadgets that make up the computer and communications industries. Physics mattered.
>
> Today, government spending on physics research has stagnated, and the number of Americans pursuing doctorates has plunged to its lowest level since the early 1960's. Especially as represented by best sellers like *A Brief History of Time*, by Stephen Hawking, and *The Elegant Universe*, by Brian Greene, physics has also become increasingly esoteric, if not downright escapist. Many of physics' best and brightest are obsessed with fulfilling a task that occupied Einstein's latter years: finding a 'unified theory' that fuses quantum physics and general relativity, which are as incompatible, conceptually and mathematically, as plaid and polka dots. But pursuers of this 'theory of everything' have wandered into fantasy realms of higher dimensions with little or no empirical connection to our reality. In his new book *Hiding in the Mirror: The Mysterious Allure of Extra Dimensions, from Plato to String Theory and Beyond*, the physicist Lawrence Krauss frets that his colleagues' belief in hyperspace theories in spite of the lack of evidence will encourage the insidious notion that science is merely another kind of religion.

String Theory is untestable – no conceivable experiment can tell if it is right or wrong. Remember the gnomes in my garden who make themselves invisible when anyone tries to observe them? An untestable hypothesis is the trademark creation of a pseudoscience. String Theory is not a theory – it doesn't even qualify as being a legitimate hypothesis. Hypotheses must be testable – somehow. String Theory isn't. You can either believe in String Theory or not – take it 'on faith' (like a religion) or reject it. If, at some future date, theoreticians are able to make a truly testable connection between String Theory and reality, then they will deserve our attention. Until that time, they are simply playing increasingly complicated games with mathematical symbols.

One concludes from articles such as these that, if cosmologists realize that

either General Relativity or the Big Bang Theory has to be thrown overboard, it is Einstein's Relativity that had better begin to take swimming lessons.

Perhaps this oncoming train wreck of untestable mathematical complexity will eventually result in the final unavoidable realization that a simpler, experimentally verifiable (electrical) paradigm is the correct one.

However, at a recent cosmology conference[42] that I participated in, only two attendees of the 30 to 40 professional cosmologists and astrophysicists presenting papers expressed any support for the notion of an unbridled Big Bang. In fact the organizers of this conference had submitted a blistering attack on the Big Bang in the form of an open letter[43] that was published in *New Scientist* earlier that spring. The letter now has over 400 signatures. Apparently the BB theory is taking on a bit of water, too. Are Einsteinians and Big Bangers vying for first class dining tables on a listing Titanic?

Some other astrophysicists have grasped at the announcement that neutrinos, which permeate the cosmos, have mass. This, they say, must be the previously missing matter. But the missing mass is not missing homogeneously throughout the universe – just in specific places (like the outer reaches of galaxies). The neutrinos are homogeneously distributed. So this last ditch explanation fails as well.

The dilemma presented by the fact that Newton's Law of Gravity does not give the correct (observed) results in most cases involving galaxy rotation can only be resolved by realizing that Newton's Law of Gravity is simply not applicable in these situations. Galaxies are not held together by gravity. They are formed, driven and stabilized by dynamic electromagnetic effects in cosmic plasmas. These are effects that can be tested and observed.

Ninety-nine percent of the universe is made up of low-density clouds of ions and electrons called electric plasma. These plasma clouds respond to the electrical physical laws codified by James Clerk Maxwell and Oliver Heaviside in the late 1800s. An additional single law formulated by Hendrick Lorentz explains the 'mysterious' galactic velocities described above. This law states that a moving charged particle's momentum (speed or direction) can be changed by application of either an electric field or a magnetic field or both. This is the cause of galaxies rotating as they do. Gravity has little or nothing to do with it.

Using the standard estimated value for the interstellar magnetic field

strength, in a volume defined by the distance between our Sun and its nearest stellar neighbor, this field alone stores an amount of energy equivalent to about 200 years of solar radiation.[44] Electric fields are even stronger. Consider the mass and charge of a proton for example. The repulsive electrostatic force between two protons is ***36 orders of magnitude*** greater than the gravitational attraction force (given by Newton's equation).[45] The point is not that Newton's Law is wrong or needs modification. It is just that in deep space, where every celestial body is swimming like a fish in an ocean of plasma, the Maxwell-Lorentz forces of electromagnetic dynamics totally overpower gravitational forces.

The Lorentz force, as defined in his equation, changes a charged particle's momentum. This change is directly proportional to the strength of the magnetic field through which the particle is moving. The strength of the magnetic field produced by an electric current (e.g., a cosmic-sized Birkeland current) falls off inversely as the ***first*** power of the distance from the current. Both electrostatic and gravitational forces between stars fall off inversely as the ***square*** of the distance. This inherent difference in the spatial distribution of electromagnetic forces as compared to gravitational forces may indeed be the root cause of the 'inexplicable' velocity profiles exhibited by galaxies.

A cosmologist defended the gravity-only approach in a discussion with me by saying, "A long straight line of mass also exhibits gravitational attraction that falls off inversely with distance just as magnetism does around a long wire." My answer to him was (and is) – we have never observed a long straight line of mass in space. No railroad tracks have ever been seen out there. What we ***do*** see are long filaments of magnetized plasma produced by long electrical currents. Although they can produce strong electromagnetic forces, these filaments do not have enough mass to produce a significant gravitational field. Those magnetic forces do not die off with increasing distance from their source as precipitously as gravitational fields do from their centers (which are stars – point sources, not railroad tracks in space).

Electrical engineer Dr. Anthony Peratt, using Maxwell's and Lorentz's equations, has shown that streams of charged particles, such as those that form the intergalactic plasma, will evolve into familiar galactic shapes under the influence of electrodynamic forces. We will examine this work in a later chapter. The results of Peratt's simulations fit perfectly with the observed

values of the velocity profiles in galaxies. No missing matter is needed – and Newton can rest easy in his grave. Electromagnetic forces are not only many orders of magnitude stronger than the force of gravity but are also distributed more widely throughout space.

To date astrophysicists and cosmologists have not given serious consideration to any sort of electrical explanation for the anomalous stellar and galactic behavior that puzzles them. This is perplexing because all these electrical principles have been known for decades. They have long been applied in the solution of problems in plasma laboratories and have been used successfully to create many practical devices – such as industrial electric discharge machining (EDM), particle accelerators, and tools used in making microchips.

The correct, simple explanation of the mysteries of galaxy rotation lies in the study of plasma electrodynamics – not in the invention of imaginary, fanciful entities such as WIMPs and MACHOs or in the trashing of a perfectly valid law of physics as is proposed in MOND.

A short allegory illustrates this present state of affairs:

A farmer and his young daughter are driving along a dusty road. They are almost home when the car breaks down. The farmer walks to the barn and gets his horse, Dobbin. He harnesses Dobbin to the front bumper of the car and the horse begins to drag it along the road toward home. The young daughter takes a piece of string, attaches it to the bumper, and says, “I’ll help drag the car, Daddy.” Anyone who cannot see horses will think the daughter must possess ‘missing muscle.‘ Or they might suggest that Newton’s Dynamics needs ‘modification’ in experiments that involve little girls who pull automobiles.

So present day astronomy–cosmology seems to be on the horns of a painful dilemma. One reason for this dilemma is the fact that Newton’s Law of Gravity does not give the correct (observed) results in most cases involving galaxy rotation and movement. The missing matter proposal attempts to balance Newton’s equation through the artifice of increasing one of the variables (one of the mass terms). The second proposal (MOND) is to change Newton’s equation itself – to make it more complicated. But the ultimate resolution of the dilemma lies in realizing that Newton’s Law of Gravity is simply not applicable in these situations – in this domain of validity. Maxwell’s and Lorentz’s equations are.

Nothing is missing.

Chapter 6

The Case of the Missing Neutrinos

Another astronomical mystery story has lain in the unsolved case file for several decades now – so long, in fact, that until recently it was getting downright embarrassing.

In 1920 the eminent authority Sir Arthur Eddington asked whether the Sun got its energy from an external or an internal mechanism. He could think of no external mechanism, but the new science of atomic physics provided a possible internal one: the fusion of hydrogen into helium.[46] So he simply assumed that was the answer and the strength of his conviction kept later astronomers from revisiting the question.

The fusion of hydrogen into helium must emit a flood of subatomic particles called electron-type neutrinos. But the measured flux of those neutrinos coming out of Old Sol has been only a fraction of the theoretically predicted value. This has become a continuing embarrassment for solar astronomers who want to believe in the Eddington assumption.

Because this failure to observe the predicted neutrino flux refutes the solar fusion model, there has been a great effort over the years to explain away the observed deficit – but none to reexamine the assumptions that gave rise to the accepted model.

There are at least three different types of neutrinos (whimsically called ‘flavors’): electron neutrinos, mu neutrinos and tau neutrinos. Prior to 2001, only electron neutrinos were measured coming from the Sun – which was all right because that was the type of neutrino that had to be emitted. But there were vastly too few of them. Only a third of the expected flux was observed.

The unanimously negative results from many similar neutrino experiments drove solar astronomers to seek help from particle physicists. Could they search for new properties of solar neutrinos that would explain the apparent deficit? The result of this search was the announcement (in June 2001) by the Sudbury Neutrino Observatory (SNO) in Canada that neutrinos actually do have mass and can change flavor. Solar astronomers hoped this would account for the apparent deficit. Some of the electron neutrinos that ‘must be there’ as they leave the Sun change flavor into one or more of the

other types of neutrino prior to arriving at Earth. These other types were not measurable in earlier experiments. The assumption that two thirds of the electron neutrinos initially emitted by the Sun convert into other neutrino flavors by the time they reach Earth was tacked onto Eddington's original assumption.

However, several important questions remain to be answered about the methodology that was used by the SNO researchers in arriving at their conclusions. Let us examine the Sudbury announcement in detail.

Press releases accompanying the SNO announcement proclaimed confidence that the standard fusion reaction is indeed alive and well at the core of the Sun. Some examples:

1. "Physicists have wrestled with the 'solar neutrino problem' since the early 1970s, when experiments detected a shortfall of the particles coming from the sun. The neutrino shortage meant either that theories describing the nuclear furnace at the sun's core were wrong or that something was happening to the particles on their way to Earth. Monday's announcement demonstrates ***with 99 percent confidence*** that it is the latter."[47]

QUESTION: What was the basis for the "99% confidence" figure? Was that a statistical result based on analysis of a sample of many alternative hypotheses? Or was it just pulled out of the blue – simple hubris?

2. "The SNO detector has the capability to determine whether solar neutrinos are changing their type en route to Earth, thus providing answers to questions about neutrino properties and solar energy generation."[48]

QUESTION: How can the SNO research team claim the ability to determine whether something happens to neutrinos on route from the Sun to Earth without making measurements at the Sun (at the start of the journey) or at least somewhere along the route? How do they know the mixture of neutrinos that arrives is not exactly what started out?

Think about the following logical equivalent of that announcement: Consider a freight train that runs from New York to Chicago. We live in Chicago and are only able to observe the train as it arrives in Chicago. It pulls in with 4 freight cars, 2 tank cars, and 1 flat car. How is it possible, no matter how sophisticated our method of observation, for us to make any conclusions whatever about whether freight cars, tank cars, or flat cars have been added to or subtracted from the train at, say, Cleveland? Moreover, how is it possible

to say that freight cars have turned into tank cars or flat cars along the route somewhere? (And do it ***with "99% confidence***"?)

There is no way that a measurement taken at only one end of a transmission channel can reveal changes that have occurred farther up the channel.

The only way such conclusions can be reached is when observations have been made at more than one place along the path – or if an assumption is made about the source.

The answer must be that they are ***assuming*** what the composition of the neutrino flux leaving the Sun is. But that makes the experiment an exercise in circular reasoning. If they know how many of each kind of neutrino are leaving the Sun, there is no need for the experiment. The experimentally obtained data adds nothing in the way of verification of the assumption.

The SNO investigators claim that they did ***not*** refer to the theoretical solar neutrino flux values. The conclusion of the Sudbury report explicitly states: "Comparison of the (neutrino) flux deduced from the ES reaction assuming no neutrino oscillations, to that measured by the CC reaction can provide clear evidence of flavor transformation *without reference to solar model flux calculations.*" [Emphasis added]

By far the most important statement in the SNO report is this one:

"If neutrinos from the Sun change into other active flavors, then CC flux will be less than the ES flux."

Recall that the 'CC flux' is the electron neutrino flux; the 'ES flux' also includes some of the other flavors. We can logically analyze the last sentence above by defining its two phrases:

(a) = Electron neutrinos from the Sun change into other active flavors.

(b) = The CC (electron neutrino only) flux measurement is less than the ES measurement.

The sentence actually says: IF (a) is true, THEN (b) is true. No one can disagree with this obvious statement. It contains no new information. Any 'if' statement can be prefixed in front of (b) because (b) will be true no matter what[49], e.g., "If up is down", then the CC flux < ES flux.

But, they are concluding that: IF (b) is true, then (a) is true. (If the measurement of the flux of electron-type neutrinos is less than the more inclusive measurement that collects some of the other types, too, then

neutrinos from the Sun must change flavor on their way to Earth.)

That is a classical logical fallacy known since the time of Aristotle: (b) will always be true even if (a) is false.

If the Sun is emitting all three flavors of neutrinos – electron, mu, and tau – then any Earthbound experiment that measures only electron neutrinos will ***always*** have a lower output than one that measures them and some of the other two types as well. This will occur whether or not neutrinos are changing flavor during the trip.

The report also states that the CC measured value is significantly smaller than the measurements yielded by an earlier experiment. So we learn that this latest electron-neutrino flux measured by SNO is even ***lower than previously reported*** levels.

Can mu-type neutrinos also revert into electron neutrinos? The SNO report did not mention this possibility. If this can occur, even ***fewer*** electron neutrinos originally left the Sun because some of those measured here actually started off in the freight train as mu-type. In other words, there seems to be a possibility that the meager electron-neutrino flux that was measured is actually ***inflated***. And that presents an even further difficulty for the SNO conclusions because of the already extremely low value of measured electron-neutrino flux.

In Batavia, Illinois, officials at the Department of Energy's Fermi National Accelerator Laboratory dedicated[50] the MINOS experiment, a beam that will send neutrinos from Fermilab, near Chicago, to a particle detector in Minnesota. In this experiment, observations will be made at both the sending end and the receiving end of the neutrino stream. Most encouraging is that this experiment ***will*** seek evidence that mu-type neutrinos turn into the other types. But what is needed to support the standard fusion model and the SNO pronouncement is evidence of electron-type neutrinos changing flavor into mu-type or tau-type – not the reverse. Indeed, a preliminary press release from Fermilab[51] said, "Our first result corroborates earlier observations of muon neutrino disappearance, made by the Japanese Super-Kamiokande and K2K experiments." Thus it seems that the mu-type neutrinos change flavor also.

It is regrettable that the SNO results do not address several other pertinent questions relative to the solar neutrino flux. For example, why does the total

flux seem to vary with the sunspot cycle? Physicist Wal Thornhill points this out in detail in his analysis of the neutrino problem at his Holoscience web site.

Neutrinos carry no electrical charge. Movements of uncharged particles (whether or not they have mass) are unaffected by magnetic fields. Therefore, the customary excuse of hidden 'strange magnetic fields that lurk beneath the Sun's surface' cannot be invoked to explain away this correlation between neutrino flux and sunspot number. Quantitative determination of the existence of a correlation between neutrino flux and sunspot number or solar wind intensity would falsify the fusion model once and for all.

The Nobel-Prize-winning scientist Irving Langmuir[52] identified several recurring principles in cases of what he termed 'pathological science':

> 1. A causative agent of barely detectable intensity produces the maximum effect that is observed, and the magnitude of the effect is substantially independent of the intensity of the cause.
> 2. The effect is of a magnitude that remains close to the limit of detectability, or many measurements are necessary because of the extremely low statistical significance of the results.
> 3. Theories outside the field's paradigm are suggested.
> 4. Criticisms are met by ad hoc excuses thought up on the spur of the moment.
> 5. The ratio of supporters to critics rises and then falls gradually to oblivion.

Clearly, the Sudbury experiment qualifies as Pathological Science under Langmuir's first principle: the paucity of data collected and its high statistical fluctuation is remarkable. It qualifies under the second principle as well: the measured effect of incoming neutrinos is undeniably of a magnitude that remains close to the limit of detectability, and many measurements are indeed necessary over a long period of time because of the extremely low statistical significance of the results.

Langmuir's third principle is clearly exhibited in this case by the cry for help astrophysicists put out to the particle physicists to ***initiate*** a search for unknown properties of solar neutrinos. A non-pathological response would have been to reexamine the basic assumptions of their theoretical solar models.

Langmuir's fourth principle is met by the fallacious spur-of-the-moment announcement that the ad hoc flavor changing is proven by a truism.

Whether Langmuir's fifth principle – the gradual disappearance of support for the hypothesis that flavor-changing neutrinos account for the deficit of electron neutrinos from the Sun – will actually occur in the future remains to be seen.

The rejoicing contained in the SNO pronouncements stands in stark contrast to the existence of blatant errors in fundamental logic contained in the report. The prime requirement in research is scientific objectivity. Given the paucity of actual data that was collected, there is substantial reason to suspect that this report was largely the product of wishful thinking.

In 2006 the Sudbury Neutrino Observatory ceased taking neutrino data. The detector had been turned on in May 1999, and was turned off on November 28, 2006. While new data is no longer being acquired, the SNO collaboration will continue to analyze the data taken during that period for the next several years. SNO currently hosts three experiments:

- The PICASSO dark matter search,
- The POLARIS underground project at SNOLAB (PUPS) , observing seismic signals at depth in very hard rock, and
- The DEAP dark matter search.

We eagerly await those results (and how they are interpreted) too.

In any event, although the solar fusion model has now seemingly been vindicated in the hearts and minds of its advocates, an objective analysis of the Sudbury (SNO) experiment reveals that "the case of the missing neutrinos" still remains far from being solved. This 'open-case' file remains open.

Chapter 7

Cosmology's Roots

We now have a fairly complete list of the shortcomings of the theories presently held dear by mainstream astro-sciences. These are errors in logic and method that have led to those failed theories we have mentioned. The list also includes ethical lapses in how inconvenient data (and the investigators who develop that data) have been treated. All these shortcomings are shrouded in a fortress-like collective mentality that rejects anything electrical. It is time for us now to examine a new paradigm that is capable of rehabilitating astrophysical science – one that cuts away the shroud of arcane complexity through which we now are forced to view the cosmos.

Plasma Cosmology and presently accepted Cosmology share a common beginning. As of now, plasma cosmologists and Einsteinian cosmologists do not agree on much of anything. But the parting of the ways for those two groups did not occur until well after the time of Isaac Newton in the late 1600s. So these now divergent schools of thought still share a revered group of early investigators.

The first time that humans looked up at the night sky and began to wonder what they were seeing was the beginning of science. It is impossible to say when and where astronomy had its origins. Who was the first astronomer? He or she was probably the first ancient Mesopotamian to look up at that glorious, unpolluted night sky and seriously ask, "What am I seeing out there?" Many names have come down to us from the far distant past: Early Greeks had the idea that the heavens were perfect, everything was spherical and Earth was at the center of the universe. Little by little, others demanded that this deductively arrived-at theory explain observations of the sky that seemed to contradict it. Many names are associated with modifications of this original 'perfect' system. Suggested revisions were proposed by Eudoxus, Callippus, Aristotle, Heraclides (who said that Mercury and Venus orbited the Sun while the Sun and all other planets orbited Earth), Aristarchus, and Apollonius.

Aristarchus

Of all these ancients, Aristarchus (310-230 BC) was closest to getting it right. He said that all the members of the solar system, including Earth, revolved about the Sun. He pointed out that the Moon revolved around Earth, and Earth rotated on its axis. His only major error was to say that the sphere of fixed stars also rotated around the Sun. Aristarchus was mostly ignored. To the extent that he was noticed, he was accused of impropriety. So, to the extent he was not ignored he was denigrated.

Critics were quick to point out that Aristarchus' heliocentric model did not explain the observed changing size of the Moon nor the unequal length of the seasons – the interval from the winter solstice to spring equinox (about 89 days) is several days shorter than from the summer solstice to fall equinox (about 94 days). These points were well taken but were later shown to be easily explainable by the heliocentric model.

Other arguments by the anti-Aristarchus critics were baseless: If Earth were rotating toward the east, then clouds should appear to move toward the west. Objects thrown vertically upward should land to the west of where they started. And if Earth is following a circular motion around the Sun, then it should alternately be getting closer to and then farther away from any given star that is in the plane of this motion. Such a star should get brighter and then dimmer over the course of the year. This was observed not to occur – this 'falsified' the theory.

By all accounts, Aristarchus did not defend his model. His contemporaries refused to accept it – it was too incredible (different from the then accepted theory). And it had problems.

Retrograde Motion

Attention (and acceptance) returned to the perfect Earth-centered Platonic system even though it too could not account for most of the phenomena used to criticize Aristarchus' model. But the most difficult problem to ignore with Plato's model was the observed periodic retrograde motion of some of the planets (Mars, Jupiter and Saturn). Although these three 'wanderers' over the course of the year usually moved from west to east against the background of fixed stars, there were times when they seemed to reverse their direction. This motion cannot be seen over the course of only one evening's observation. But

over several nights, the relative position of these three planets can be seen to change slowly relative to the stars behind them. So it seemed that they moved irregularly. Occasionally they moved in what would seem to be the wrong way – backwards – toward the West. Why?

The real cause of retrograde motion is simple to understand. Earth is closer to the Sun than Mars, Jupiter or Saturn and moves faster – takes less time to make a revolution around the Sun than any of them do. Earth has the inside track, and it is moving faster. Consider the period of time that starts just before Earth and Mars (the next planet out from us) are in line with the Sun. Earth is just about to pass Mars out. From night to night we see Mars moving eastward against the backdrop of the fixed stars. But as Earth catches up to and passes Mars, Mars appears to move westward for a while before resuming its eastward direction.

This is analogous to when we are driving along an interstate highway. Our car is in the left lane and we are about to pass a slower vehicle in the right lane. Look at the other car when we are still quite a distance behind it: It appears to move toward the left against the forest that is in the distant background. But as we come up next to it, the other car appears to be moving backwards (toward the right) relative to the fixed trees. Finally, when we get far enough in front of it, the other car seems to travel again toward the left with respect to the forest.

It is just simple geometry. But this geometrical concept eluded the ancient astronomers. It wasn't that Aristotle and others had not studied geometry (Pythagoras lived from 569 BC until about 475 BC); it was that, in this case, results from one of these two areas of study were not seen as being relevant to the other just as today's astrophysicists refuse to see the importance of electricity to astronomy.

Hipparchus and Ptolemy

Hipparchus (~100 BC) invoked the notion that bodies that exhibit retrograde motion must move in cycloids rather than simple circular paths. Ptolemy (85-165 AD) extended this idea by applying complexity to the epicycles[53] and by using mathematics to describe the motions. All this effort to make the earlier geocentric model more complicated was a futile quest to

enable it to explain retrograde motion. As a result, each planet was determined to have its own ‘deferent circle’ and epicycle. The level of complexity of the accepted model of the cosmos was getting out of hand.

Copernicus (1473 – 1543)

Nicholas Copernicus (b. 1473) cut through the complication of the modified Ptolemaic system by recognizing that the relatively simple model of a Sun-centered solar system was sufficient to explain everything, including retrograde motion of the planets. Even he flirted with the idea of epicycles. But the idea of a heliocentric solar system was a breakthrough. It was as if he had applied Occam’s Razor. Had he heard of William of Occam’s ideas? We know he had heard about the work of Aristarchus.

Galileo (1564 – 1642)

Later, Galileo (~1620) tried to advance the acceptance of the Copernican view of the cosmos, and we all know the trouble that brought him. The powerful theocracy then in power strongly believed that the heavens were made by God and were therefore perfect. Earth was profane. But the sky was sacred. Thus, it was sacrilegious to turn a telescope toward the sky and question the perfection of what God had made. Any implication that the sky was less than the realm of perfection described by Plato and Aristotle was also sacrilege. The Cardinals were perfectly willing to look at distant buildings through Galileo’s telescope during the day. They refused to look through it at the night sky. Galileo’s contributions were mainly in the political scheme of things. He did observe the four large moons of Jupiter and sunspots. He showed that Venus exhibits phases,[54] but his lasting contribution was that he serves as a prime example of how political power can limit discovery and impede scientific progress.

Johannes Kepler (1571 – 1630)

In 1606 he published De Stella Nova (Concerning the New Star) on the new star that had appeared in 1604; and in 1609 his Astronomia Nova (New

Astronomy) appeared, which contained his first two laws: 1. Planets move in elliptical orbits with the sun at one of the foci, and 2. The radius vector from the Sun to a planet sweeps out equal areas in equal times. His third law states that the squares of the periods of the planets are to each other as the cubes of their mean distances. Now astronomers could predict where the planets would be at any given time. But they didn't know what held them in their orbits.

Isaac Newton (1643 – 1727)

Newton developed the Universal Law of Gravity: "All matter attracts all other matter with a force proportional to the product of their masses and inversely proportional to the square of the distance between them." This explained ***why*** Kepler's laws worked. It was also tested by experiment. It successfully predicted the outcomes of these experiments and was properly designated as being a legitimately accepted Theory. Astronomers now knew what paths the planets were constrained to follow and they knew what force held them there.

This is when astronomers stopped learning about any other forces that act on matter in the cosmos – because they believed they knew everything they needed to know.

Benjamin Franklin (1706 – 1790)

Franklin was a 'natural philosopher,' which is what we call 'a scientist' today. In June of 1752, he flew his famous kite – with a key attached to the string – in a lightning storm, narrowly avoiding electrocution. But he successfully managed to determine that electricity existed in the sky. Franklin claimed that his experiment showed not only that lightning was an electrical phenomenon but also that the sky itself was inherently electrical in nature. Astronomers paid little attention to this. They considered it unimportant to their investigations.

James Clerk Maxwell (1831 – 1879)

Our knowledge of electricity developed in the next century after Franklin. There are many names associated with this scientific advance, but none of them was particularly interested in the cosmos. Scottish physicist and mathematician J. C. Maxwell codified all of the important knowledge about electricity into a set of equations, which even today form the basis of all electrical science and engineering. Actually, Maxwell had reduced all the earlier disconnected work into some twenty self-consistent equations. Oliver Heaviside then further reduced those into the four compact vector calculus relationships Maxwell is now credited with. He showed that electric currents cause magnetic fields. He showed that magnetic fields could not exist in the absence of an electric current or a time-varying electric field. Most importantly, he demonstrated how ***electromagnetic*** energy propagates through space. In so doing, he defined the ***Electromagnetic Spectrum*** and showed that visible light is only an extremely small part of that spectrum.

Lord William Thompson Kelvin (1824 – 1907)

Lord Kelvin was perhaps the single most influential scientist in Britain circa 1900. He was not at all reticent, offering his opinions on almost all scientific topics of the day. Many of his observations were correct and are still valid today. In others he fell short of the mark. For example, regarding Maxwell's seminal work in electricity, he commented, "The so-called 'electromagnetic theory of light' has not helped us hitherto.... [I]t seems to me that it is a rather backwards step."

He also said, "Radio has no future" and "Wireless [telegraphy] is all very well but I'd rather send a message by a boy on a pony."

At the British Association for the Advancement of Science in 1900 he pontificated, "There is nothing new to be discovered in physics now. All that remains is more and more precise measurement." Embarrassingly for his memory, this was precisely at the time that Henri Bequerel, Wilhelm Roentgen, and Pierre and Marie Curie were developing the beginnings of the science of nuclear energy. Unfortunately, astronomers who felt that starlight was all they would ever need to be concerned with also became strongly influenced by Kelvin's anti-electrical mindset.

The parting of the ways between standard visual astronomers and those

who were interested in investigating the astronomical implications of the entire electromagnetic spectrum can be dated from about 1900 – 1910. That decade saw the birth of Plasma Cosmology.

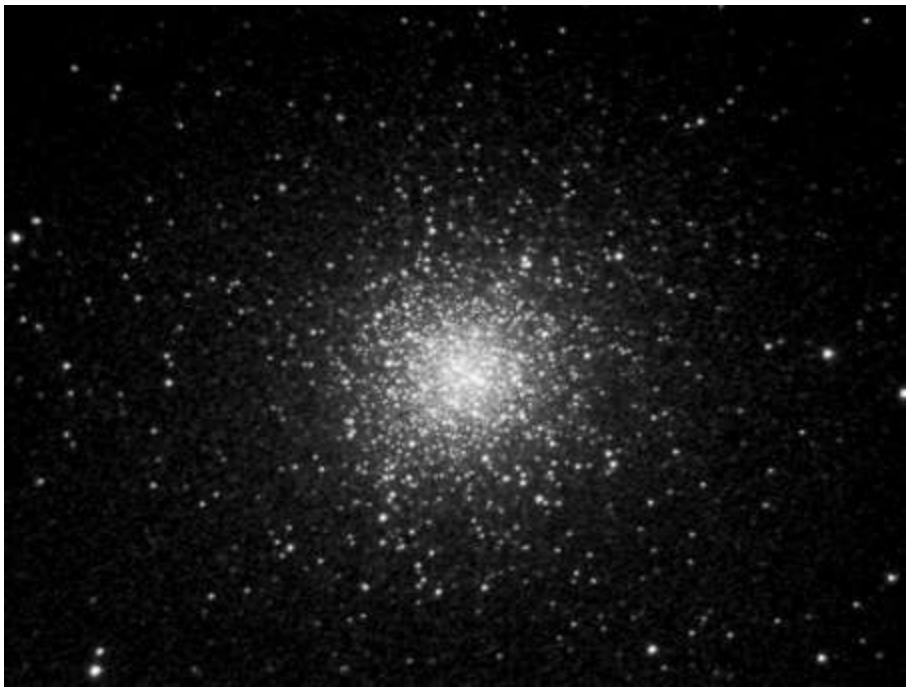


Image by the author

Plate 2: The great globular cluster, M13. This cluster is 145 light-years in diameter and contains over 100,000 stars. These stars appear to be almost on top of one another, but the average distance between them is more than three light years.

Chapter 8

The Plasma Pioneers

Just before the dawn of the Twentieth Century, the magnificent aurora borealis displays in the northern night sky captivated the attention of a highly intelligent scientist, a man with an excellent understanding of the then new science of electricity. He realized that to determine the cause of the auroras he had to leave his laboratory and gather actual data out in the frozen Land of the Midnight Sun. That man was Kristian Birkeland. He was the first physicist[55] to look up at the night sky and seriously consider the idea that electricity might be actively at work out in space. No one else did. The development of what has come to be called Plasma Cosmology is a tale of both physical and intellectual heroism. Birkeland started it all.

In the late 1800s and early part of the Twentieth Century, things were somewhat different in science from the way they are now. Individual scientists were pretty much free to investigate what they wanted, to announce their ideas and to publish their results. Birkeland decided to dedicate his career to solving the mystery of the aurora. He did not have to get anyone's permission to do it. He just did it. This was before the advent of Big Science. The peer review system had not yet gained control over what research areas were to be allowed to thrive.

Today most science is done within the confines of laboratories and universities. Government and private funding agencies exert firm control over the direction and acceptability of scientific investigation. If a lone investigator has an idea that runs counter to the scientific establishment, that idea is not likely to be funded and thus not likely to be investigated. This has been the fate of electric plasma cosmology, especially recently.

But let us begin at the beginning.

Kristian Birkeland

In 1898 Birkeland was a professor at the University of Christiania (now Oslo). He knew how electricity behaves. He was familiar with Maxwell's

Treatise on Electricity and Magnetism.[56] But most important, Birkeland was a willing data gatherer. He went out from his lab and took his measurements of geomagnetic activity underneath those aurora displays – risking both his own life and those of his men in that bleak twenty-four-hour winter darkness. He built remote observing stations in northern Norway, where he and his assistants almost froze to death several times in their treks across those vast windswept snowfields.

He was the first person to propose that electric currents come from the Sun, flow into Earth's upper atmosphere, and cause the auroras. These currents pass through and excite the plasma that exists high above Earth's surface to such a degree that it becomes visible: it begins to glow. In those days the word ***plasma*** had not yet been applied to the phenomenon that Birkeland was investigating. He talked simply about 'electric effects' in the upper atmosphere.

Maxwell had demonstrated that electric currents and magnetic fields are inextricably interrelated. But Birkeland stood alone in proposing that electric currents from the Sun cause the auroras. Only he (since Franklin) said that electricity is important in the cosmos – that our sky is an electric sky.

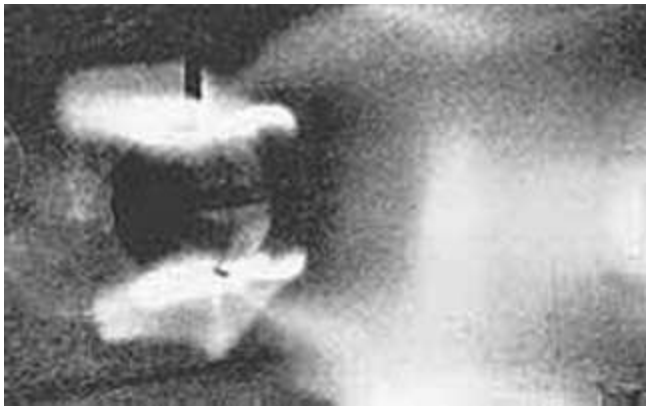


Figure 5: Birkeland's Terrella in operation.

Birkeland was roundly criticized by mathematical theoretical physicists who never left their desks to do the kind of experimental data-gathering that he had done. They claimed that his theory was impossible because mutual repulsion of like charges within any current stream coming from the Sun

would dissipate that stream before it reached Earth. The theorists did not yet know that the plasma surrounding the Sun, and in which all the planets reside, is a good electrical conductor for exactly that kind of stream of charges. Birkeland had stood out under the aurora and measured it.

Although Birkeland is best known for his investigations of the auroras, his vacuum chamber experiments with magnetized metal spheres, which he called ‘terrellas,‘ are equally significant. An electromagnet inside a metal sphere was slightly tilted to mimic the angle by which Earth’s magnetic axis is tilted away from its rotational axis. The vacuum chamber into which he placed the sphere mimicked the space that surrounds Earth. A cathode within the chamber supplied an electric current to the sphere just as Birkeland thought the Sun does to Earth.

Lucy Jago, in her biography of Birkeland, *The Northern Lights*,[57] describes the first demonstration of his terrella:

> Once Birkeland was satisfied that electrons were streaming from the cathode, he flicked the switch beside the chamber and powered the electromagnet in the terrella. Within seconds, a purple glow could be seen encircling Earth at the equator. As Birkeland increased the strength of the magnetic field around the Earth, the circle divided, and two circles began to move toward the poles. The audience fell silent as the two spiral rings of glowing phosphorescent light hovered around the poles of the Earth, eerie and magical. After a few minutes Birkeland turned off the magnet and the cathode in the terrella; the glow disappeared, and the audience took a collective breath.

Copies of Birkeland’s 300-page book, *The Norwegian Aurora Polaris Expedition 1902-1903*, published in 1908, were sent to eminent scientists and heads of state all over Europe. It was very well received in all countries – except in Britain. Why this happened is unclear. Was it because Newton was an Englishman, and British astronomers sensed a threat to the ‘gravity only’ cosmological mindset even at that early time? Was it because Kelvin had already made clear his antipathy toward electromagnetism? Whatever the reason, there was a decidedly anti-electrical attitude within English scientific circles. Hostility toward electrical effects in astronomical (and auroral) phenomena continued to predominate in British and American science.

A particularly tenacious English mathematician, Sydney Chapman, who

was interested in geomagnetism, continually denigrated Birkeland and criticized his work for half a century. Chapman's ideas about auroras involved the kinetic theory of neutral gases and a 'dynamo' which he said was driven by tidal flows in Earth's ionosphere. Fifteen years after Birkeland's death, Chapman admitted that plasma from the Sun caused the auroras. But he continued to belittle Birkeland's work.

As late as 1967, Chapman said that Birkeland's "direct observational contributions to auroral knowledge were slight." An American scientist and electrical engineer, Alex Dessler, a former editor of the prestigious journal, *Geophysical Research Letters*, questioned Chapman about Birkeland. "I asked him whether Birkeland's work had any influence on him at all. He glanced at me and said, 'How could it? It was all wrong.'"

With the advent of high altitude rockets and satellite technology, Birkeland's explanation of the aurora was found to be correct. Today Birkeland is acknowledged as having been the first scientist to accurately determine, through heroic observation in the field, laboratory experimentation, and theoretical description, the correct cause of the auroral displays – electric current from the Sun flowing in plasma and causing that plasma to emit light.

Birkeland also discovered the twisted corkscrew-shaped paths taken by high-intensity electric currents in plasmas. Sometimes those twisted shapes are visible and sometimes not – depending on the strength of the current.

A somewhat counterintuitive result of Birkeland's work was the discovery that electric currents in space tend to ***follow*** magnetic fields, not cut across them. Today, because of this discovery and in his honor, these spiraling streams of ions and electrons that we observe in space are called Birkeland Currents. The strange 'sprites,' 'ELVES,'[58] and 'blue jets' associated with electrical storms on Earth are examples of Birkeland currents within the plasma of our upper atmosphere. The Helix Nebula[59] is another example at a stellar scale.

When Birkeland died, the Nobel awards committee was considering his name. His portrait is on the 200 Kroner Norwegian currency to this day.

Lucy Jago says of this pioneer, "Birkeland now has a crater on the Moon named for him, which, together with Birkeland Currents and the wider acceptance of his work, should prevent his memory from fading, but rejection

of his theories probably slowed the advance of geomagnetic and auroral physics for nearly half a century."

Another writer said of him, "Misunderstood in his lifetime, some of Birkeland's ideas about our universe are now considered brilliantly prophetic." But Birkeland was not misunderstood. He was just tenaciously opposed by lesser men.

After Birkeland's passing, several other electrical scientists and engineers followed in his footsteps, promoting and defining the part played by electrical phenomena in cosmic plasmas.

Irving Langmuir

Irving Langmuir was born in Brooklyn, New York, in 1881. He graduated from Columbia University in 1903 as a metallurgical engineer. Then he studied physical chemistry, earning his master's and doctorate degrees in Göttingen in 1906. After graduation he returned to the New York City area and began teaching at the Stevens Institute in Hoboken, New Jersey. In 1909 he began working with electrical discharges in low-pressure gases in his laboratory at General Electric in Schenectady, NY.

Langmuir discovered the now famous double sheath, or double layer (DL), effect in plasmas. He further developed the body of knowledge Birkeland had initiated. He coined the term ***plasma*** to describe the almost lifelike, self-organizing, self-sustaining behavior of these ionized clouds in the presence of electric currents, magnetic fields, and foreign bodies that were inserted into them. Prior to this time, this research field had been called 'electrical discharges in gases.'

The misnomer 'discharges in gases' encouraged scientists who were experts in gas dynamics to think they were automatically also experts in these discharges. The realization that theories describing how gases flow have nothing to contribute to the understanding of plasma phenomena came hard. Some investigators still find it a difficult pill to swallow.

Langmuir arrived at his hypotheses by combining knowledge from several different fields. Hannes Alfvén, another of the pioneers of electric plasma theory, offered this comment about Langmuir[60]:

> The facts his always-active brain combined were anything from

electrical discharges and plasmas to biological and geophysical phenomena. Science as fun was one of his cardinal tenets.

From this, one gets the impression that he was very superficial. This is not correct. He won a Nobel Prize in Chemistry because he was recognized as the father of surface chemistry. He knew enough of biology to borrow the term plasma from this science, and the mechanism of double layers from surface chemistry. Langmuir's probes were of decisive value for the early exploration of plasmas and double layers, and they are still valuable tools.

Langmuir discovered many properties of plasma, including the 'plasma frequency' that we will describe later. His most important tool for investigating plasma in his lab is still used and to this day carries his name – the Langmuir probe.

Langmuir held the tenets of science in high regard. He was proud to be a scientist and did not suffer lightly any work that he felt was in any way shoddy or not based on firm experimental evidence and thorough investigation. He is well remembered for publishing his description of what he termed Pathological Science that was referred to earlier.

During his professional career, Langmuir was awarded many honorary degrees and prestigious awards in addition to the Nobel Prize. He was elected to the Royal Society in London, was made Fellow of the American Physical Society, President of the American Chemical Society and President of the American Association for the Advancement of Science. He died in 1957.

Hannes Alfvén

Hannes Alfvén was born in Sweden in 1908. As a young student, he became interested in amateur radio and astronomy. Those were the early days of radio, and his achievement of building a working radio receiver while he was still in high school presaged his later career in advanced high-energy electrical discharges.

His early attempt to develop a theory of the origin of cosmic radiation was published in *Nature* in 1933. He studied physics at Sweden's Uppsala University and earned the degree of Doctor of Philosophy there in 1934.

Alfvén studied the work of Kristian Birkeland. In 1939 Alfvén proposed

another remarkable hypothesis regarding magnetic storms and auroras that has widely influenced contemporary theories of plasma dynamics in Earth's magnetosphere. He used the tendency of electric charges to spiral in magnetic fields to calculate the motions of electrons and ions. This method came to be universally adopted by plasma physicists and remained in use until the tedious task was assigned to computers in the mid-1970s. Yet in 1939, when Alfvén submitted a paper describing this work to the American journal *Terrestrial Magnetism and Atmospheric Electricity*, the paper was rejected on the grounds that it did not agree with the theoretical calculations of Chapman and his colleagues.

In 1940 he was appointed Professor in the theory of electricity at the Royal Institute of Technology in Stockholm, Professor of electronics in 1945, and Professor of plasma physics in 1963. In 1967 he became a visiting professor of physics at the University of California at San Diego. In 1970 he was awarded the Nobel Prize in Physics.

Alfvén was the first to predict (in 1963) the large-scale filamentary structure of the universe, a discovery that confounded astrophysicists in 1991 and added to the woes of Big Bang cosmology. Hannes Alfvén has played a central role in the development of several modern fields of physics, including plasma physics, the physics of charged particle beams, and interplanetary and magnetospheric physics.

Twenty years before the discovery of the Van Allen radiation belt, Alfvén developed the basic tools we use today to describe it. He proposed a mechanism explaining the acceleration of cosmic rays that is now known as the Fermi Mechanism. Alfvén did it before Fermi. And he fought for years to make astronomers aware of the existence and importance of electric fields and currents in space.

In the last half of the Twentieth Century, an ongoing dispute ensued between Alfvén and the astrophysics community. Alfvén considered himself to be, first and foremost, an electrical power engineer who had experienced and measured the various plasma phenomena that often occurred on the super-high-voltage electrical transmission lines and circuits in his native Sweden. From his knowledge of astronomy, he could see the applicability of his plasma discoveries to the study of cosmic phenomena. He rather enjoyed the accusation of being an 'outsider to astrophysics,' thrown at him pejoratively by theoretical cosmologists and others such as Sydney Chapman.

He was an expert in a research field they had never studied. He knew the physics of both electric plasmas and astronomy.

Figure 6: Hannes Alfvén accepting the Nobel Prize in Physics from the King of Sweden – 1970.

When Alfvén entered a large astronomical convention hall, a hush would fall over the crowd. Any discussion about how space was electrically neutral would immediately cease. Alfvén had the deep respect of professional astronomers, but they almost never heeded his advice. It was their loss.

Alfvén continued the earlier experimental work of Kristian Birkeland and Irving Langmuir on electric plasmas. He, his students, and associates developed the theoretical and mathematical foundation for those earlier experimental results. Alfvén was awarded not only the Nobel Prize in Physics but also the Gold Medal of the Royal Astronomical Society (1967), the Gold Medal of the Franklin Institute (1971), and the Lomonosov Medal of the USSR Academy of Sciences (1971).

But even he and his co-workers were not able to change the mindset of most astrophysicists who decided to follow the unsound, purely deductive mathematical approach championed by Chapman and his followers. It continues to be standard procedure to view as ‘flawed’ any observations made either in earthbound electric plasma laboratories or in space that conflict with traditional mathematical models that ignore the importance of electric currents and fields and that treat plasmas as if they were gases.

Anthony L. Peratt

Anthony Peratt earned his doctoral degree under the direction of Hannes Alfvén at the University of Southern California. He is a member of the Associate Laboratory Directorate of the Los Alamos National Laboratory where, on assignment to the U.S. Department of Energy, served as a Scientific Advisor and Acting Head of Nuclear Nonproliferation. He currently serves on both the Executive and Administrative Committees of the Institute of Electrical and Electronic Engineers (IEEE).

Dr. Peratt is a world-renowned electrical engineer who first received notice from the public for his work with computer simulation of galaxy formation, published in Eric J. Lerner's 1991 book *The Big Bang Never Happened*. Peratt had worked on those simulations for several years prior to that time.

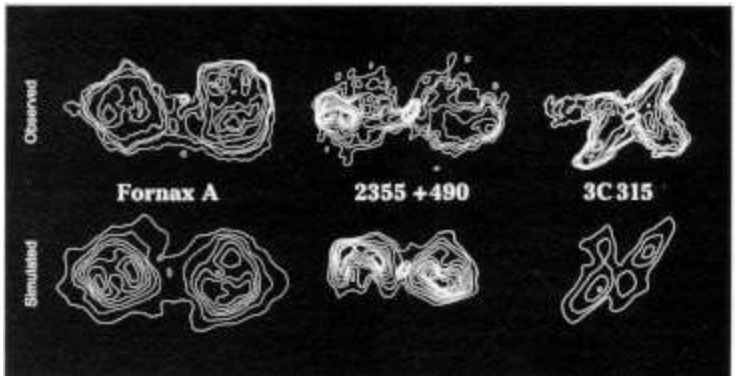
By 1986 he had achieved sufficient professional stature to be asked to serve as Guest Editor of the December 1986 *IEEE Transactions on Plasma Science.*[61] In that issue he published two articles: "Evolution of the Plasma Universe: I. Double Radio Galaxies, Quasars, and Extragalactic Jets"; and "II. The Formation of Systems of Galaxies."

In the issue of the *IEEE Transactions* that Peratt edited, there were two articles by his mentor, Hannes Alfvén. There were other articles by the astronomer Halton Arp as well as many top plasma scientists and engineers. It is a seminal publication that sets out the fundamental basis of the Electrical/Plasma Universe. It is, for the most part, readable by any reasonably informed layperson interested in astronomy. It should be available in the library of any good college of engineering.

Dr. Peratt used an extremely large computer to apply the Maxwell-Lorentz equations (the basic laws governing the forces produced by, and the interactions between, electric and magnetic fields) to each member of a huge ensemble of charged particles. This technique is called Particle in Cell (PIC) simulation, and its accuracy has been verified by comparing its results with laboratory experiments. His simulations are almost indistinguishable from astro-images of actual galaxies. The gravitational effects in the PIC simulation proved to be negligible.

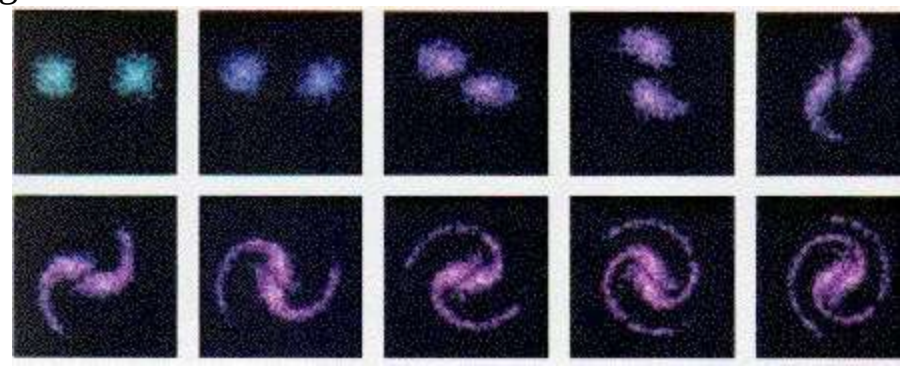
He went on to publish the text *The Physics of the Plasma Universe* (Springer-Verlag, 1992). It presents the mathematical laws of physics that govern the behavior of plasmas. It provides the fundamental mathematical

arguments for why electrical effects cannot be ignored in any modern study of the cosmos.



Credit: Anthony L. Peratt

Figure 7: Some of Peratt's simulations compared to actual double-radio galaxies.



Credit: Anthony L. Peratt

Figure 8: Peratt's simulation of galaxy formation with two Birkeland currents.

Peratt has an extensive website[62] containing information for both the novice who wants to learn about the Plasma Universe and the experienced investigator who wants to download the seminal scientific papers that underpin all these ideas. It is a treasure trove of essential information about the electrical nature of our Universe.

Wallace Thornhill

In my lifetime I have had the privilege of meeting only a few people who always think calmly, precisely, logically, and unemotionally, who have an

unerring knack of going to the heart of any matter at hand, and then have razor-sharp insight into possible solutions and explanations. Australian physicist Wallace Thornhill, in my mind, is at the top of that extremely selective class.

When I asked about his academic background, Thornhill replied, “Concerning academic credentials, a few words of explanation are necessary because I gave up their pursuit as irrelevant during my first postgraduate year. Academic credentials are awarded based on an assessment by one’s peers in a chosen field. I found I had no peers because I was exposed to the notion of the importance of electromagnetism in celestial dynamics years before entering university.”

When he entered the university, the lack of curiosity and even hostility to what he considered interesting and valid questions were devastating to him. Nevertheless, he graduated with honors from Melbourne University in 1964 with a B.Sc. in physics and electronics. He taught himself to grind a parabolic mirror and built his own astronomical telescope. In his final year he was selected for admission to postgraduate study and worked with Professor Hopper’s group in upper atmosphere research. He then joined IBM as a scientific programmer. His career since has been in computing, involving high-level, innovative software development.

Thornhill has told me that what characterizes his scientific attitude is: “I have never been satisfied with not knowing what goes on inside a black box.” He always wants to seek reasonable answers to the question “How does this thing really work.”

Thornhill left academe because he realized that there was little future for him there if it was not open to rational discussion of the kind of ideas that concerned him – electric effects in the cosmos. Instead, he has made it a point throughout his professional life to attend lectures and seminars by leading researchers to keep pace with science. Some of the institutions he regularly attended (and still does) are: The Research School of Earth Sciences, Australian National University; Mount Stromlo & Siding Springs Observatory of the Australian National University; Research School of Physical Sciences of the Australian National University. While living in London for five years in the 1980s, he attended seminars at The Royal Astronomical Society; the British Astronomical Association; the Society for Interdisciplinary Studies, where he was a committee member; The University

of London, Queen Mary College, where he took a M.Sc. course in astrophysics; and the British Association for the Advancement of Science.

Clearly Thornhill has earned, by his lifelong study of electrical astrophysics, the equivalent of at least one, if not several, doctorates.

He tells an anecdote that demonstrates the extremes to which present-day astronomers will go to avoid confronting the idea that a given phenomenon is obviously electrical in nature:

On one of his many visits to Mt. Stromlo Observatory, which was quite near his home in Canberra, Australia, a young Ph.D. student presented a seminar on the topic of "Non-Thermal Filaments in the Galactic Center." She said that this topic represents "one of the greatest mysteries of the Galactic Center" and it "possesses intriguing characteristics." She admitted in her introduction that such filaments when first seen were thought to be an error in the data-reduction algorithm.

She then spent an hour describing the object, known as 'The Snake,' in terms of twisted magnetic flux tubes. Yet Thornhill saw immediately that the object had all the characteristics of a galactic Birkeland Current discharge. Its twist was explained by the student as being (presumed) rigid magnetic connections to a (presumed) rotating molecular cloud at each end. The student explained that she was spending up to 10 hours a day on a supercomputer using a magnetohydrodynamic (MHD) model to explain the 'kinks' (plasma instabilities) in The Snake. The MHD model is based on a *non-resistive plasma*, a concept that Alfvén showed decades ago is purely imaginary.

Thornhill then told me, "From early experience, I knew that if I had asked a question about Birkeland Currents at the end of the presentation it would not have been understood and I would have been sent to face the corner with a dunce's cap on. There is almost a sense of being a time traveler from the future, sitting in on lectures about how the Earth is flat and knowing that the Earth isn't flat but feeling helpless to speed up the scientific process. As Arthur Koestler might have put it, it's like being the only one awake amongst a group of sleepwalkers."

Thornhill ended his story by restating his most closely held belief: "It is important to listen critically to what academics are saying and discovering, but the lessons learned best are those where we think for ourselves."

The famous electrical scientist, Michael Faraday (1791-1867) once said:

> The scientist should be a man willing to listen to every suggestion but determined to judge for himself. He should not be biased by appearances, have no favorite hypothesis, be of no school, in doctrine have no master. He should not be a respecter of persons but of things. Truth should be his primary object. If these qualities be added to industry, he may indeed hope to walk within the veil of the temple of Nature.

Image by the author.

Plate 3: Spiral Galaxy M33 (NGC 598). This is a member of our ‘local group’ of galaxies. Compare its shape with Peratt’s simulations shown in figure 8.

In my mind Wal Thornhill personifies the man in that quotation.

A good part of the content of this book results from discussions I have been fortunate enough to have with both Wallace Thornhill and Anthony

Peratt. It is important to be cognizant of the fact that ***none*** of these pioneers of the Electric/Plasma Universe was trained as (or by) astronomers.

Chapter 9

Shake Hands with the Plasma

Why does electric plasma appear to behave in strange ways? We cannot see gas. We cannot see magnetic or electric fields. So why can we sometimes see plasma and sometimes not? What is it – really? How does it work?

The usual way to describe plasma is to say it is a cloud or stream of ionized gas. This is true as far as it goes, but it is also misleading. Although the atoms of the elements that constitute a plasma do have mass and are therefore subject to gravity, electromagnetic forces are far stronger than gravity. Plasma therefore does not obey the same laws of physics that clouds of gas or streams of fluid do. It obeys the laws of electromagnetism, not gravity. Plasma can light up, and it can squeeze itself into threads of current; it can separate into cells; it can isolate intruders and shield itself from them.

The glowing stuff inside the glass tubing of neon signs is electric plasma. So is the arc of an electric arc welding machine – and so is lightning. The corona of the Sun is plasma. The ionosphere of Earth is an example of a plasma that does not emit visible light (except during auroras).

The electrons that flow inside a copper wire also constitute a plasma. Those electrons respond to electrical forces, not gravitational ones. We do not have to place our coffee maker at a lower level than the power outlet in the wall so that gravity can enable the electrons to run downhill like water in a river. Charges moving within plasma are just like an electric current in a wire – moving charges driven by electrical forces that completely ignore gravity. A plasma can be thought of as being a ‘sea of electrical charges.’ We have found that these ‘seas’ occur in many places.

Plasma in Space

Plasma permeates our solar system. The cloud of particles that constitutes the solar ‘wind’ is a plasma. Our entire Milky Way galaxy consists mainly of plasma.[63] In fact 99% of the entire universe is plasma.

If we are to understand phenomena in the universe, we must examine this form of matter that makes up so much of the cosmos and is so enigmatic for

present day astronomers. Why does it act the way it does?

Think about a cloud of gas. This gas might be contained in a glass tube in a laboratory or it might be floating in deep space. It is made up of widely separated atoms of an element or assortment of elements.

An electric current (a flow of charged particles) passing through this gas can strip away one or more of the outer (valence) electrons from some of the atoms. We say that these atoms have become ***ionized***. What remains of each such atom (the protons, neutrons, and any remaining electrons) exhibits a net positive electrical charge and is called a positive ion. The freed electron, of course, carries an equal but negative charge. If, instead of stripping off an electron, one is ***added*** onto a neutral atom, the combination carries a net negative charge and is called a negative ion. It will carry the same negative charge that the electron does, but it will have the additional mass of the original atom.

At any given instant inside the typical operating fluorescent lamp, positive ions are moving in one direction and negative ions in the other direction. Ions respond to electric and magnetic fields. The atoms in neutral (uncharged) gases do not.

The Cause of Electric Currents in Plasma

An electric current flowing in a wire is analogous to water flowing inside a pipe. The water flow is measured in gallons per minute; the electric current is measured in Coulombs per second, which is also called Amperes (Amps for short). The water flow is caused by applying a higher pressure at one end of the pipe than at the other. An electric current is caused by applying a higher voltage at one end of the wire than at the other.

The voltage difference between the two ends of the wire sets up an electric field (***E***-field) within the wire. The strength of this ***E***-field determines the force on each of the charges in the wire. The stronger the ***E***-field, the greater the force on each charged particle; this pushes it along – collectively, this creates the current.

An ***E***-field (force per unit charge) also radiates outward from every positively charged particle or object and inward toward any negatively charged particle. Therefore, two positive ions will exert a repelling force on each other. This electrical force between two ions is many orders of

magnitude stronger than the mechanical force of gravity. When some of the atoms in our gas cloud become ionized, turning the cloud into a plasma, those ions move in response to any applied ***E***-field, and collisions with neutral atoms may sweep the entire cloud along, overpowering the effects of gravity or gas dynamics.

Plasmas are good – but not perfect – conductors of electric current. They act much like wires in this regard. So we do not usually have to consider gravitational forces acting between the ions in plasma any more than we have to worry about gravity affecting the electrons inside the wire leading to our coffee pot.

Modes of Operation of Plasma

Whether plasma is visible to the human eye is determined by its operating mode. Plasma can operate in three different steady-state modes:

1. Dark Current Mode: The present day ionospheres of the planets are examples of plasmas operating in the dark current mode. Earth's own ionosphere does not usually emit light (except during auroras). The ionosphere sheaths Earth in a cell of plasma, separated from the plasma of interplanetary space (the solar wind). The strength of the electric current within this plasma is extremely low. The plasma does not glow. Its low energy causes it to radiate the longer wavelengths of radio waves instead of visible light. We would not know plasma was there except for measuring its electrical activity with sensitive instruments – such as radio receivers.

2. Normal Glow Mode: The strength of the electric current in the plasma is significant. The entire plasma glows– as it does in a neon sign. The brightness of the glow depends on both the intensity of the current and the density of the plasma. The color depends on what gas is being ionized. Other examples are auroras, emission nebulae, and comet tails. The Sun's corona is a plasma in the glow mode, which we see during solar eclipses.

3. Arc Mode: The strength of the electric current in the plasma is very high. The plasma radiates brilliantly over a wide spectrum, including ultraviolet light and radio frequencies. Humans must be very careful

not to look directly at an arc plasma because strong ultraviolet light can permanently damage the eye. Electric current tends to form twisting filaments in arc plasma. Examples of this mode of operation are electric welding machines, lightning, the Sun's photosphere, the Sun's looping prominences, the filaments in penumbrae of sunspots, and the spark that jumps from your finger to the doorknob on dry winter days.

At any given time, the strength of the current density (Amps per square meter) that is passing through the plasma determines its mode of operation. As a rule of thumb, the stronger the electric current, the brighter the plasma. We will discuss these modes of operation in more detail in a later chapter. Clearly, however, a plasma will not be visible unless it is carrying a fairly strong electric current. That was the key that Birkeland used to unlock the mystery of the auroras.

Double Layers

Irving Langmuir discovered that one of the most important properties of plasma is its ability to isolate electrically one section of itself from another. The isolating wall is made up of two closely spaced layers, one consisting of positive charges and the other of negative charges. Langmuir called it a double sheath. Today it is called a double layer (DL).

Because plasmas are excellent conductors, there will not be a significant[64] voltage drop across them while they are carrying current. If there is a significant voltage difference between two locations within a plasma, a DL will form between them and most of the voltage difference will be contained in it. In other words, a DL is where the strongest electric field in any plasma will be found.

Plasmas have an almost magical ability to isolate themselves from foreign intruders. If anything is inserted into a plasma, a DL will surround it and isolate it from the plasma. This effect makes it difficult to insert voltage-sensing probes into a plasma in order to measure the electric potential at any

specific location. It is this ability to isolate an intruder and surround it with a protective sheath (as human blood can) that probably inspired Irving Langmuir to use the term ‘plasma’ in the first place – and then to develop his ingenious probe that enables us to measure such voltages in the laboratory.

Electrical Charge and Voltage

One should be clear about the relationship between the quantities ***voltage*** and ***charge***. Any physical object has the ability to store electric charge (analogous to the way a bucket can store drops of water); that capability is called the object’s ***capacitance***. Electrical ***capacitance*** is akin to the water carrying ***capacity*** of the bucket.

Using the water bucket analogy, the height of the water in the bucket (and therefore the pressure at its bottom) is analogous to the voltage on the electrically charged object. Adding a given amount of water to a small diameter bucket will result in a higher water level – and hence more pressure at the bottom – than adding the same amount of water to a large diameter bucket. Analogously, adding charge to a tiny object will raise it to a higher voltage than will adding the same amount of charge to a bigger object.

Voltage is a relative quantity. Like velocity, it must be measured with respect to some reference datum. How fast is a fly moving when it is inside the cabin of a high-flying jet aircraft? Answer: Four hundred miles per hour with respect to the ground but only one mile an hour with respect to the seats in the cabin. If we are asked, “How high is the voltage of that comet,” we can only answer, “How high is it compared to what?” It is impossible to send a spacecraft to measure directly the voltage of the solar plasma at any given point.

But charge is not relative. Just as the amount of water in a bucket does not depend on the amount in any other bucket, the amount of charge on an object does not depend on the amount of charge on any other object.

Before it is launched, a spacecraft will carry just enough charge (the amount depends on its capacitance) to maintain a zero voltage difference between itself and the surface of Earth. After launch, as it penetrates Earth’s plasmasphere and enters the solar plasma, it will slowly accumulate charge. This accumulation of charge will slowly reduce to zero the voltage difference between the vehicle and the plasma through which it is traveling. That is why

space probes cannot measure voltages directly – a voltmeter with one terminal connected to the spacecraft and the other extended outside into the plasma will eventually read zero.

The strength of an electric ***field***, however, ***can*** be measured by space probes. Devices called electric field 'mills' yield accurate measurements of ***E***-field strength in units of Volts per meter (V/m). These instruments are often carried on space probes.

Plasma Frequency

Irving Langmuir also discovered what is called the plasma frequency. Electrons, being less massive than ions, move more rapidly. He found that in plasma, free electrons move back and forth around the slowly moving +ions, a movement called harmonic motion. The frequency of this back and forth oscillation of the electrons is called the plasma frequency.

If an electromagnetic wave (e.g., a radio signal) tries to pass through a plasma, it may get through – or it may not. The determining factor is whether the frequency of the incoming radio signal is higher than the plasma frequency. If it is, the radio wave goes through the plasma as if it were transparent. If the frequency of the incoming radio signal is lower than the plasma frequency, energy from the signal is used up in accelerating the plasma's electrons. This results in the signal energy being absorbed or partially reflected from the plasma.

This is why radio waves are reflected back from different plasma layers in Earth's upper atmosphere. This effect enables intercontinental radio communication at certain (low) frequencies. Very-high-frequency signals penetrate the upper atmospheric layers and are lost into space. Of course, if our goal is to communicate with a spacecraft, then we want to use sufficiently high-frequency signals to penetrate the ionospheric plasma.

This is also why spacecraft reentering the atmosphere experience the familiar 'blackout' period. Radio communication cannot penetrate the plasma sheath that forms around a spacecraft as it reenters.

For sensors in space, our Earth is a source of kilometer-long wavelength radio signals. The notion that planets such as Earth could emit radio frequency signals was long derided by astronomers. These transmissions are due to auroras high above the ionosphere. Since their frequency is much

lower than the plasma frequency of the ionosphere, they cannot be detected on Earth's surface and were first heard only when satellites traveled above the ionosphere.[65]

Birkeland Currents and the Z-Pinch

High-intensity electric current passing through a plasma will take on the corkscrew (spiral) shape discovered by Birkeland. These Birkeland currents most often occur in pairs and tend to compress between them any material (ionized or not) in the plasma. This is called the 'z-pinch' effect. In 1934[66] W. H. Bennett first studied this ability of cosmic electric currents to accrete and compress even non-ionized material. This z-pinch (or Bennett pinch) mechanism may explain the observation that cosmic matter tends to form an abundance of filamentary, stringy structures. It is being used presently here on Earth in attempts to create manageable, sustained fusion. Astronomers have long thought that a major effect of magnetic fields in space was to disperse matter. Instead, we see through Bennett's work that just the opposite effect occurs when cosmic currents align themselves with magnetic fields to form Birkeland currents.

Frozen–In Magnetic Fields

For years astrophysicists have assumed that plasmas are perfect conductors and any magnetic fields would have to be 'frozen' inside them. Any movement of the plasma would bring the magnetic field along with it. In fact it was Hannes Alfvén who first proposed the idea. One of Maxwell's equations requires that, in any region of ideal ('perfect') conductivity, magnetic fields cannot vary in any way – thus they will appear 'frozen in place.' Alfvén reasoned that if plasma is an ideal conductor, then magnetic fields inside them are frozen – end of story.

But the electrical conductivity of any material, including plasma, is determined by two factors: the ***density*** of the population of available charge carriers (the free ions and electrons) in the material and the ***mobility*** of these carriers (how easily they can move). In any plasma, the mobility of the ions is extremely high because electrons and ions can move around quite freely in

space – almost never colliding with other particles. But the concentration (number per unit volume) of these particles that are available to carry charge may not be at all high – especially if the plasma is a very low-pressure (diffuse) one, as they typically are in space. So, although plasmas are excellent conductors, they are ***not*** perfect conductors. Weak electric fields can and do exist inside them. Therefore, according to that same equation of Maxwell's, magnetic fields are ***not*** frozen inside them.

In his 1970 acceptance speech of his Nobel Prize in Physics, Alfvén pointed out that this idea of 'frozen-in' magnetic fields, which he had earlier endorsed, was false. In reality, moving magnetic fields within a plasma create electric currents. This fact is one of the basic concepts embodied in the Electric Sky.

Hannes Alfvén was unique among Nobel laureates in taking the opportunity of his acceptance speech to declare that ***he had been wrong*** in what he had said previously. Alfvén said, "I thought that the frozen-in concept was very good from a pedagogical point of view, and indeed it became very popular. In reality, however, it was not a good pedagogical concept but a dangerous 'pseudo-pedagogical concept.' By 'pseudo-pedagogical' I mean a concept which makes you believe that you understand a phenomenon whereas in reality you have drastically misunderstood it."

When he used the term 'classical plasma theory,' Alfvén was referring pejoratively to this erroneous 'frozen-in' idea and its cause – the false assumption that plasmas are 'ideal conductors.' When discussing the failure of this so-called classical approach in the search for controlled nuclear fusion, Alfvén pointed out that:

> The 'thermonuclear crisis' did not affect cosmic plasma physics very much. The development of the theories continued because they largely dealt with phenomena in regions of space where no real check was possible. The fact that the basis of several of the theories had been proven to be false in the laboratory had very little effect. One [astrophysicist] said that ***this did not necessarily prove that they must also be false in the cosmos***. Much work was done in developing these theories, leading to a gigantic structure of speculative theories which had no empirical support.

The claim that something we have proven to be impossible here on Earth

may still be possible in deep space is scientifically unsupportable and intellectually dishonest. Astrophysicists have used it more than once. No science should ever employ this kind of fraudulent evasion. The notion that it is somehow legitimate to invoke mechanisms and entities that are demonstrably impossible (that have been falsified by experiment) so long as they happen far away in deep space is irrational. It is similar to accepting the idea that all things are possible if we only step Through the Looking Glass and then just believe in them.

Because plasmas are good (but not perfect) conductors, they are equivalent to wires in their ability to carry electric current. It is well known that if a wire cuts through a magnetic field a current will flow in that wire. This is how electric generators and alternators work. Therefore, if there is any relative motion between a cosmic plasma, say in the arm of a galaxy, and a magnetic field in that same region, Birkeland currents will flow in the plasma. These currents will produce, in turn, their own magnetic fields, which will generate more currents in plasmas moving relative to them.

Critical Ionization Velocity

Astronomers long denied the possibility that there could be separated charges in space. In 1942 Alfvén suggested a mechanism for how charge separation in space can occur. He calculated that if a plasma (ionized cloud) passes through a neutral cloud with sufficient relative velocity, the neutral gas would become ionized. Based on his work, this ‘critical ionization velocity‘ was predicted to be in the range of 5 to 50 km/sec.

Alfvén’s prediction was experimentally verified in a plasma laboratory in 1961. The critical ionization velocity is often called the ***Alfvén*** *critical ionization* ***velocity***. There is ionization in space. This is why. The bees ***do*** fly.

Predictions of Plasma Cosmology

Anthony Peratt states in his book[67] *The Physics of the Plasma Universe* that the density of electrons in interplanetary space is somewhere between 10^{-3} and 10^{+3} per cubic centimeter. This is equivalent to between $4x10^{12}$ and $4x10^{18}$ per cubic mile. So, the volume of space defined by the Earth–Sun

distance contains a thousand billion billion billion billion electrons. Our solar system is permeated by electric charge. If the density in intragalactic space (inside our galaxy but outside the solar system) is only one millionth of that, the charge density there is still quite high (on the order of a billion ion – electron pairs per cubic mile).

The gravitational pull between our Sun and its nearest companion is equal to the gravitational attraction between two specks of dust separated by a distance of 4.3 miles. Which force do you think controls the movements of the galaxies – Gravity or Electrodynamics?

Recently Dr. Peratt was asked whether there is anything we would expect to see in the plasma cosmology model that we would not expect to see in the Big Bang model? Peratt's answer was essentially the following:

We live in a universe of plasma. And a universe of plasma differs significantly from what might be called Newton's Universe, a universe of stars and solid masses acted upon and controlled only by gravity. The presently accepted 'gravity-only' universe is one whereby all matter was created in a single instant and reacts only to gravity under the modifying ideas of general relativity.

A plasma universe and a gravitational universe have gross observational differences. A plasma universe should be filamentary – stringy – at all size scales (in the atmospheres of planets, in the Sun's corona, in groups of stars, in galaxies and in strings of galaxy clusters). It should be energetic, a source of electromagnetic radiation over the entire electromagnetic spectrum, and it should be endless in space. The gravitational universe – the 'big bang' universe – is supposed to have produced all the elements originally, should now be quiescent in the absence of mass collisions, and should be increasingly smooth on the large scale. The filamentation, chaos, and radio-frequency radiation that we now observe were not expected in the original big bang model.

Another difference is that a universe of plasma in chaotic motion tends to produce cells of plasma of different voltage, temperature, density, and chemical properties, just as is observed in the laboratory. It is the relative motion of these cells that generates both electric currents and charge separation when the cells drive through each other. These electric currents produce magnetic fields. Charge separation causes electric fields to exist.

So, filamentation, chaos, electric and magnetic fields, intense charged

particle beams, broadband radiation from extremely low frequencies to gamma-rays, and an overall cellular structure were the predictions of a plasma universe, as developed at the end of the Nineteenth Century. Unfortunately we had to wait about one hundred years for all this to be verified.

The invention of 'cosmic strings'[68] was astrophysics' response to the mounting evidence in the mid- to late-1980s of the filaments that were being discovered everywhere – filaments that plasma physicists suggested were to be found in space even in the 1890s. But astrophysics, based on their homogeneous non-electrical, mathematical models had as a fundamental tenet that the universe was basically smooth and became smoother as distance increased.

Much that is being observed now was predicted by plasma models decades ago. Plasma scientists wondered how astrophysicists would respond because they knew that the behavior of active plasmas was not within astrophysicists' school of thinking. One response came in 1969 with John Wheeler's black hole innovation in an attempt to explain how gravity could produce the tremendous energies associated with certain galaxies. Wheeler originally said the black hole was so strong that nothing could escape it, not even light (electromagnetism). But then new observations showed the existence of jets, so the black hole concept was modified by Stephen Hawking to allow radiation to escape after all.

This was followed, circa 1976, with the proposal of 'cosmic strings' to explain the mysterious filaments and strings of objects (e.g., galaxies) that were being discovered everywhere.

Any paper that interprets energetic events in terms of black holes is now accepted almost automatically for publication in the astrophysical journals. This has become a religion: It is now a sacrosanct belief that black holes exist regardless of the fact none has ever been observed and that simpler plasma-based explanations are readily available.

Such models are fluid and sterile. They are constantly being changed to account for new data being discovered almost weekly. They are made of silly putty.

The galactic and stellar jets, along with their observed synchrotron (non-thermal) radiation, are not at all similar to a stream of water. But this is all

that astrophysicists can simulate in their non-electrical models. A hydro-jet does not emit synchrotron radiation.[69] Astrophysicists are not able to simulate synchrotron radiation, nor can they find a way to create the magnetic fields that are associated with these structures – not without electric currents.

Plasma Is More Than Hot Gas

Press releases continually misuse the word ***gas***, using it for what should properly be called ***plasma***. The following examples are taken from American Astronomical Society (AAS) releases:

> RIVERS OF GAS COULD BE PART OF MISSING MATTER (Ohio State U., 2/11/03)
>
> A gas cloud, one trillion times more massive than our Sun and more than 150 times hotter, surrounds our local group of galaxies.... [T]his gas cloud is only part of larger rivers of gas that wind between all the galaxies in the universe….
>
> GAS CLOUDS MAKE NEW TELESCOPE (CSIRO Australia Telescope National Facility, 4/11/03)
>
> Our galaxy has an invisible 'atmosphere' – a thin gas of electrically charged particles that fills the space between the stars.
>
> CHANDRA DETECTS HALO OF HOT GAS AROUND MILKY WAY-LIKE GALAXY (Marshall Space Flight Center, Huntsville and Chandra X-ray Observatory Center, 7/19/01)
>
> Chandra found the diffuse halo of x-ray gas to be radiating at a temperature of almost 3 million degrees.

In the past three years, more than 200 AAS press releases have misused the word ***gas*** where the word ***plasma*** should have been used. Because of this improper usage, readers are being detoured away from a true understanding of the phenomena we see in the sky. This is especially apparent in the first example (above) about Rivers of Gas. The public will naturally tend to assume that these ***gas rivers*** are following gravitational contours in space because accurate descriptions of moving magnetic fields, electric currents and plasmas are being excluded from these releases. And of course any river that

the public is familiar with ***does*** respond to gravitational force and sometimes to winds.

Magnetohydrodynamics

Astronomers are now reluctantly aware of the existence of cosmic plasma, but they attempt to describe its behavior by means of magnetism and equations that are applicable only to the flow of fluids. This is what Alfvén called ‘magnetohydrodynamics.’ They do not realize, as he did, that the prefix ‘magneto-’ implies ‘electro-.’ And that, in turn, explains why astrophysicists talk about stellar ‘winds,’ ‘vortex trails,’ and ‘bow shocks’ instead of electric plasmas, currents, electric fields, z-pinches, and double layers. It also explains why they make incorrect claims about how magnetic fields ‘pile-up,’ ‘merge,’ and ‘reconnect’ – they are simply unaware of, and are therefore mystified by, this now well-known area of engineering-science.

The Plasma Universe

The American Institute of Physics has just recently announced that they will now recognize the Plasma Universe as an official field of study in physics – a field of study astrophysicists would do well to explore. It is based on the work of Birkeland, Langmuir, Alfvén and Peratt.

Some people call plasma ‘the fourth state of matter’[70] (after solids, liquids, and gases). Actually, plasma is the ***first*** state of matter. On December 11, 1970, Hannes Alfvén ended his Nobel Prize acceptance speech with these words:

> It was the wonders of the night sky, observed by Indians, Sumerians, or Egyptians, that started science several thousand years ago. It was the question why the wanderers – the planets – moved as they did that triggered off the scientific avalanche several hundred years ago. The same objects are now again in the center of science – only the questions we ask are different. We now ask how to go there, and we also ask how these bodies once were formed. And if the night sky on which we observe them is at a high latitude, outside this lecture hall – perhaps over a small island in the archipelago of Stockholm – we may

also see in the sky an aurora, which is a cosmic plasma, reminding us of the time when our world was born out of plasma.

Because in the beginning was the plasma.

Chapter 10

The Electric Sun

Our Sun is the closest star to Earth. Other than Earth itself, it is the most important body in the universe – for us. The disappearance, in an instant, of all the other stars, planets and moons in the universe would affect us very little. But without the Sun, there can be no life on Earth. Our precious star is very hot and sometimes has spots on it. Everyone knows that. But, how does it generate its energy?

The Standard Solar Model

Establishment astronomers appear certain about how the Sun generates its power and what is occurring deep down within it. They claim that the core of the Sun is a continuous nuclear fusion reactor. This core occupies 20% of the Sun's radius. Surrounding the core is a radiative zone wherein heat energy is transported away from the core by photons. This zone occupies some 50% of the Sun's radius. Sitting on top of this structure (and occupying the remaining 30% of the radius) is another zone in which heat is carried to the surface by convection columns – very much like hot air rising from the top of a hot stove. The entire journey from the core to the surface takes between 100,000 and 200,000 years. This claim is called the 'standard model.' Of course, nobody has ever been able to see into the Sun. But lacking any other reasonable model for how the Sun functions, astronomers generally have accepted this one as being true.

This description sneaks in a subtle assumption – that the 'surface' of the Sun is the top of the convection zone and is the final stage of the mechanism that makes the Sun shine. But this is not true. The top of this assumed convection zone is only the 'photosphere,' the surface that we see in visible light.

A more complete description would include the Sun's physical form beyond the photosphere. Next we come to the chromosphere, a relatively thin layer approximately 2000-3000 km in height. In comparison to the much brighter photosphere, it glows faintly in red. The standard model does not

predict its existence.

The Corona and the Solar Wind

Above the chromosphere lies an extended glowing plasma structure that we can see during solar eclipses – the corona. Beyond the corona, an invisible plasmasphere extends many times the distance of the planet Pluto. The corona and the plasmasphere carry streams of ions and electrons that have been named the ‘solar wind.’ The standard model provides no reason for the existence of the corona, the plasmasphere or the solar wind.

Temperature Minimum

If the standard model were correct, heat and light would simply radiate away from the photosphere as from a hot stove. But many processes, other than simple radiation of heat, are occurring above the photosphere.

A temperature minimum occurs just above the photosphere. The lower regions of the Sun’s corona, quite high above the visible surface, are millions of degrees ***hotter*** than the surface of the Sun itself. How can this be? The standard model has no satisfactory explanation for it.

Variations in the Solar Output

The flux of ions that the Sun emits in the solar wind varies in intensity. The ion stream sometimes stops completely. How? Why? And the ions in the solar wind accelerate – their velocity increases the farther away from the Sun they get. How? Why? Again the standard model has only *ad hoc* explanations for these observations. (The phrase solar ‘wind’ is a serious misnomer. A flow of ions constitutes an ***electric current***, not a wind. We do not speak of an electric ‘wind’ flowing in the wires leading to our coffee maker. We will use the phrase reluctantly – only because of its popularity among astronomers and science writers.)

The Sun rotates more rapidly at its equator than near its poles. The magnetic fields near sunspots reverse polarity from one eleven-year sunspot cycle to the next. These and many other observed phenomena associated with the Sun give strong indication that a high level of ***electrical*** activity is at

work on and above the surface of our local star.

It should be clear that the standard model is at least incomplete if not totally wrong in its description of the Sun's structure. Astronomers defend this standard model by saying that all the processes they describe have been performed in the laboratory and are well known. But nothing could be further from the truth. Mankind has been doggedly struggling for over half a century to create a sustained nuclear fusion reaction in the laboratory. We have not even come close to doing it. It may not even be possible. The only experiment that has been performed that fuses hydrogen into helium and liberates tremendous amounts of energy is the hydrogen bomb. That reaction is almost instantaneous. Recently discovered inherent instabilities in the plasma that is generated by the process may make it impossible to control it and make it occur continuously. Just to ***assume*** that such a sustained process is alive and well in the Sun's core is a stretch.

Plasma Effects

It is now well known that the space within our galaxy is filled with plasma. Every charged particle in the plasma has an ***electrical*** potential energy (voltage – measured in Volts) just as every pebble on a mountainside has a ***mechanical*** potential energy with respect to sea level. Every particle of matter in the universe has a certain amount of mass. It also can carry electrical charge – either positive, negative, or zero. Therefore, every composite particle within a galaxy, such as each star, planet, moon, asteroid, and comet, also has its own unique electric potential (voltage) with respect to the plasma surrounding it.

Electric Solar Model

In the Plasma Universe model, electric currents create the galaxies and the stars within those galaxies via the electromagnetic z-pinch effect. It is a logical extrapolation to propose that these currents, once having formed the stars, continue to supply electrical energy to them. Galactic currents have low current *densities* (the number of Amps per square meter of the flow's cross-section are low), but because the sizes of the stars are large the *total* stellar input current (total Amperage) to each of them is high. Is it enough for the

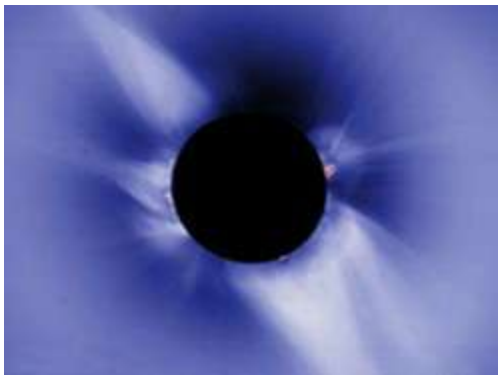
Sun to generate its vast power output electrically? So far space probes have gathered insufficient data to answer this question. It can only be answered empirically.

The Electric Sun (ES) hypothesis is an outgrowth of the Electric/Plasma Universe theory that came into being through the work of many researchers from Kristian Birkeland to Hannes Alfvén. The researcher who is the prime organizer of these ideas about the Sun is the late engineer Ralph E. Juergens of Flagstaff, Arizona. But as with so many innovative ideas in science, he did not originate his hypothesis out of the blue. He had carefully studied the earlier plasma research of a Scots mathematician and physicist, C. E. R. Bruce. Bruce had made the first major change in the theory of how lightning paths function since their description by Franklin. This work and his attendance at Sydney Chapman's 1941 Kelvin Lecture on 'The Sun' led Bruce to apply these ideas to cosmic phenomena and to a new electric vision of the universe.

External Power

In the ES hypothesis, the power source of the Sun does not lie deep within it. The Sun receives a fairly steady electrical input from the galactic currents that we now know exist in our Milky Way and other galaxies.

Juergens was the first investigator to propose that the Sun sits at the focus of not only the orbits of each of its planets but also a huge plasma cloud. Astronomers call it a 'bubble.' It is properly termed a plasmasphere.



Credit: UCAR/NCAR High Altitude Observatory

Figure 9: The Sun's coronal plasma.

Because of its size, the Sun has a large electric capacitance (ability to hold charge). This capacitance receives charge from cosmic currents that exist in our arm of the Milky Way galaxy. The Sun thus exhibits a relatively high voltage. Electrical power (in Watts) is equal to the product of voltage (in Volts) times current (in Amperes).

Juergens calculated that the Sun's voltage, multiplied by the total value of the current coming toward it, is sufficient to produce the Sun's observed power output. He therefore concluded that the Sun is powered by its galactic environment, not from within itself.

'Little' Problems Can Be Theory Falsifiers

Whether or not Juergens was completely correct in his assertion that the Sun is totally powered by external electrical excitation is really not the most important point of the ES hypothesis. What ***is*** important is that all of the phenomena we observe on and above the surface of the Sun are clearly well-known effects in electric plasma. This is true no matter how the Sun gets its power.

The ES model predicts and explains these phenomena. In contrast, the standard model does not predict their existence and offers no inherent explanations for why they occur. Mainstream astronomers dismiss these phenomena as being of secondary importance – temporary glitches for which ad hoc explanations will be developed sometime in the future. In reality they are loose strings, which, when pulled, unravel the entire fabric of the standard model.

A Comparison of Models

Let us examine the Juergens model – the Electric Sun – and compare it to the standard fusion model.

Back in 1979 Juergens said, "The certainty that the Sun generates its prodigious outpourings of energy through thermonuclear reactions deep in its interior has been with us for about half a century." During that entire period of time, and right up to the present, in almost every article or TV program

produced for the public, the very first sentence usually contains some reference to the ‘fact’ that the Sun is, at its core, a sustained thermonuclear fusion reaction.

The noted British scientist Sir Arthur Eddington first proposed the fusion model as being the Sun’s power source. He rejected out of hand the proposal that the Sun might be getting its energy from outside itself because he could not conceive of how that might happen. And the then new science of nuclear physics provided a possible mechanism for an internal source: nuclear fusion. What is happening deep in the Sun’s core, according to this now accepted model, is that hydrogen atoms are being fused into helium atoms and, in the process, are liberating vast amounts of energy.

As we described earlier, in Eddington’s standard model the energy produced by fusion in the Sun’s core supposedly rises slowly away from the center toward the surface first by radiation (no movement of material) and then by convection (a flow of matter upward). The granulations we see on the surface of the photosphere are supposedly the tops of 150,000-mile-long ‘convection columns’ – stable tubes of rising matter that transport heat energy up from the Sun’s core toward the surface. Presumably that matter sinks back down toward the bottom of the convection zone along the edges of the tubes.

But if this complete process actually takes 150,000 years, then why do the ‘granules’ change shape and even disappear in a period of hours?

Juergens pointed out that, given what we know about the Sun, smooth, stable convection columns are impossible. He calculated the ‘Reynolds number,’ an indicator of the likelihood that smooth laminar flow can occur in a body. When the Reynolds number exceeds a critical value, flow will be turbulent and highly complex, not in ‘laminar columns.’ His result was far above that critical value. He wrote, “Clearly, then, any convective motion [within the Sun] should be violently turbulent and highly disordered. Many facile assertions to the contrary, it becomes increasingly obvious that [the existence of] photospheric granulation is explainable in terms of convection columns only if we disregard what we know about convection. Surely the cellular structure is not to be expected.”

Many solar astronomers dismissed his arguments out of hand. However, perhaps the most eminent solar astronomer of all, Dr. Eugene N. Parker,

wrote,[71] "the Reynolds number [in the convection zone] is on the order of 10^{12} and, perhaps worse, the convective zone is vertically stratified."

In an ironic way, Sir Arthur Eddington was very much like my great-aunt Emma.

Emma was in her seventies right after World War II ended. Her son-in-law, Harry, bought her a present – her first television set. It was a Philco and had a big 7-inch screen. We plugged it in and watched the fights from St. Nicholas' Arena in New York City. When the program was over, we watched intently as the musical ad for Gillette Blue Blades came on – in those days we even watched the commercials with enjoyment.

Eventually, when the set was turned off, Aunt Emma thanked Harry profusely and said she was going to enjoy having the TV set and watching it. But she wondered how she was going to load new pictures into the set so she could watch a different program. Harry smiled and said, "Oh, Emma, you never have to load any new pictures into the set. The pictures and the sound come through the air just like radio." Emma laughed, "Oh, Harry, it's not nice to try to fool an old lady like me – even ***I*** know that's impossible."

So astronomers agreed that it was obviously impossible for the Sun to receive power externally. Like Aunt Emma, Eddington and his followers just could not conceive of a process whereby the Sun could be getting its energy from the outside. Solar astronomers jumped onto the 'sustained nuclear fusion is the only possible way to power the Sun' bandwagon and it is still rolling along today even though the idea suffers from many obvious creaks, groans, and deficiencies.

Power is not usually generated where it is used. There is a well-known anecdote about two aliens flying over brilliantly lighted Los Angeles at night in their space ship. They look down and wonder how so much energy – enough to make all that light – could possibly be generated in such a small place.

Of course, the electrical energy is not generated within Los Angeles. Most of it is produced at Hoover dam and at other power plants hundreds of miles away. The power is transported by transmission lines to its eventual destination. Birkeland currents make efficient, invisible electric power transmission lines in space. Given the density of the plasma surrounding the Sun, it is not at all inconceivable that this is exactly how the Sun functions.

Mechanical and Electrical Potential Energy

Energy is simply the ability to perform work. Animals eat food in order to gain energy. They expend this energy in the process of living, expanding their lungs, pumping blood, walking, climbing, etc.

Suppose we have a bowling ball sitting at sea level at the bottom of a vertical cliff. Let us pick up the ball and climb to the top of the cliff. Put the ball down at the edge of the cliff-top. In carrying the ball up there, we have given it mechanical potential energy. Whoever carries the ball has lost that amount of energy (not to mention the work done in lifting his own body up there too). The bowling ball now has the potential of doing work. Potential energy is simply due to the location of the ball within Earth's gravitational field – the higher it is, the more potential energy it has.

There is a second type of mechanical energy called kinetic energy. This type of energy has nothing to do with the position of the ball, only its velocity. A speeding locomotive has lots of kinetic energy no matter how far above sea level it is.

We can convert our bowling ball's potential energy into kinetic energy by simply edging it off the cliff. As the ball drops lower and lower down the face of the cliff, it goes faster and faster (it accelerates) – converting the potential energy it had at the top of the cliff into kinetic energy. By the time the ball finally hits the ground, it will have converted all its hilltop potential energy into kinetic energy. When it hits, it will then use this kinetic energy to dig an indentation in the earth and perhaps create a sound or even slightly raise the temperature of the ground right beneath it.

Any charged particle has an ***electrical*** potential energy. This electrical potential energy is measured in Volts. So if we move a +ion up to a region of high voltage (we have to put energy into it to get it there), it will have the potential ability to do work. We can convert its electrical potential energy into mechanical kinetic energy, just as we did with the bowling ball. When a +ion falls from a higher to lower voltage, it will accelerate – it will gain kinetic energy.

This is exactly what happens inside a TV cathode ray picture tube. Charged particles (electrons) accelerate from a region at the rear of the tube where they have high electrical potential energy (but almost no velocity)

toward the screen where they have zero electrical potential. But by that time, they have converted that potential energy into ***kinetic*** energy. They smash into the chemically treated rear surface of the screen and emit light. In fact the earliest TV cameras were called '***kine***scopes' for this reason.

We can draw a picture of the shape of the cliff from which we dropped the bowling ball. The image will be a cross-section of the cliff, perhaps showing the top of the cliff on the left and the ground (sea level) at the right. We can label the vertical axis of this plot 'Potential Energy' and the bottom (horizontal) axis 'Horizontal Distance.'

It is also possible to sketch a similar electrical potential hill for a +ion. The only difference is that the vertical axis will represent electrical potential energy rather than mechanical potential energy. It will be labeled in Volts.

Energy Possessed by Ions at the Sun's Surface

A similar sketch can explain Juergens' model of how the Sun operates. The entire structure of the Electric Sun model (ES) is really nothing new – it is simply an extrapolation in size of well-known laboratory plasma phenomena. Juergens' genius lay in his recognition of the applicability of this voltage plot, so well known in plasma labs, in describing the mechanisms that produce observed solar phenomena. What is of crucial importance in his model is the description of how charged particles (+ions and electrons) behave at the Sun's surface – and why.

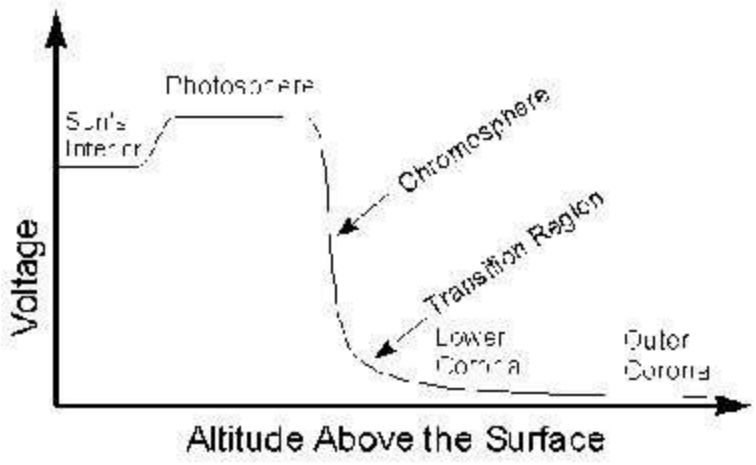


Figure 10: The voltage levels in the Sun's atmosphere.

In figure 10 we see the cross-section of the electrical potential landscape that exists at and above the surface of our Sun. This plot shows us very quickly that the photosphere[72] is the highest voltage region – it is the top of the hill in so far as +ions are concerned. Any +ions that may be milling around inside the Sun's interior (at the extreme left of the diagram) will be blocked from escaping outward (toward the right) from the Sun unless they have enough kinetic energy to surmount the energy rise from the Sun's interior up to the photosphere. The existence of the stream of ions called the solar wind is evidence that some ions can do exactly that. But more about that later.

The plasma in the photosphere is operating in the arc mode – it is emitting brilliant white and ultraviolet light. Ions in this region skate around like a collection of hockey pucks on an almost frictionless ice rink (on the top of the hill). The intensity of their random movement (called Brownian motion) is measured by the temperature of this region. It is around 5800 K.[73]

Because of the Sun's positive voltage, it acts exactly like the anode (positive terminal) in a laboratory plasma discharge. As such, it exhibits many of the phenomena observed in earthbound plasmas, such as anode tufting. The granules observed on the surface of the photosphere are anode tufts (plasma cells in the arc mode).

Why do the tufts seem to disappear and then reemerge in relatively short periods of time? The voltage plot in the above figure is drawn for positively charged particles. In order to visualize the effect this energy diagram has on electrons coming in toward the Sun from cosmic space (from the right), we can simply turn this energy plot upside down. (Electrons are negative charges, and what is a high energy level for a +ion is a low energy level for an electron.) Doing this enables us to visualize the 'trap' (or pit) that each photospheric tuft is for incoming electrons. As the trap fills with electrons, the bottom of this inverted pit will rise, and so the tuft weakens, shrinks, and eventually disappears. This is the cause of the observed shrinkage and disappearance of photospheric granules. Another tuft immediately replaces each disappearing tuft – remember the lifelike ability of plasma to sustain itself.

The high-voltage plasma in the photosphere is separated from the low-voltage plasma of the lower corona by the chromosphere. The voltage drop from the top (photosphere) to the bottom (lower corona) of the potential hill

is in the order of 10^9 V or more. This chromospheric layer is approximately 2000 km wide (high). It contains a plasma double layer (DL). Most of the radio-frequency noise emitted by the Sun emanates from this region. Radio noise is a well-known property of DLs.

Temperature Minimum

How such an intensely hot body as our Sun can have a temperature ***minimum*** just above its hot photosphere is not easy for the standard fusion model to explain – but straightforward for Juergens' electrical model.

The temperature minimum lies in the general area of the photosphere-chromosphere boundary. This is extremely puzzling to solar astronomers because any typical source of radiant energy is expected to obey an 'inverse square law.' That is to say, the farther we get from a heat source, the less energy we receive and the lower the temperature will be. A wood stove is hottest at its core, a bit less on its outside surface, and beyond that surface the radiant energy we receive ought to diminish continually with distance. This analogy was used in the cover article in the June 1, 2001, *Scientific American*, entitled "The Paradox of the Sun's Hot Corona," by Bhola N. Dwivedi and Kenneth J.H. Phillips, to describe the problem of the 2-million-Kelvin temperature of the Sun's lower corona: "It is as though you got warmer the farther away you walked from a fireplace."

Near the Sun's visible surface, the photosphere, its temperature is only about 5800K – and is even cooler at the deepest part of its sunspots. But, as we go outward from the photospheric layer, the temperature of the atmosphere first slowly falls to approximately 4000K (as it should). Even lower (3800 K) temperatures have recently been measured. Beyond that minimum point, the temperature begins to ***rise***, first gently and then abruptly to about ***2 million*** K in the plasma of the lower corona[74].

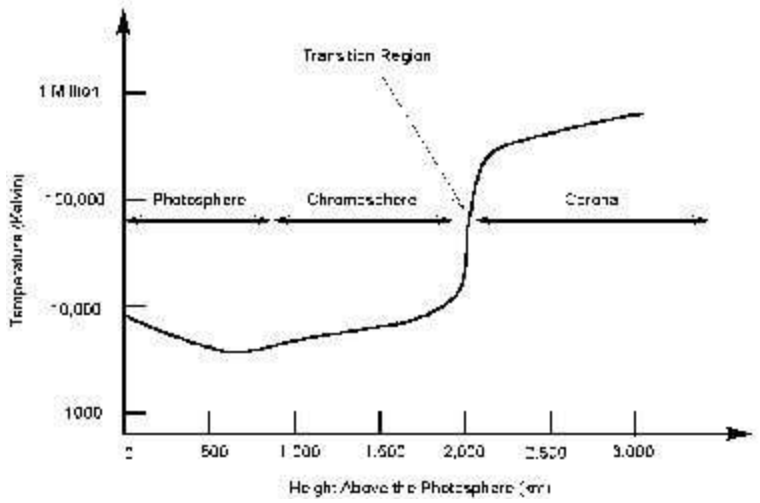


Figure 11: The strange temperature profile of the Sun.
(Note: The vertical axis in this figure is logarithmic.)

Many mainstream astronomers view this temperature discontinuity as an inconvenience for which several *ad hoc* explanations have been offered. One noted astronomer actually told me that the minimum was because the temperature sensor "couldn't see the entire sun when it was too close to the surface." I then asked him if a mosquito hovering right next to a blazing wood stove would find it cooler there than farther out because he "couldn't see the whole stove". I am sure that if he had time to reconsider his response, the astronomer would have thought better of it.

A few astronomers are less complacent:[75]

> One of the great mysteries of the Sun is *why it has a solar corona*. At the height of the photosphere (the visible surface of the Sun), the temperature is ~5880K. The temperature then decreases with height for several hundred kilometers. But then something amazing occurs: at greater heights, the temperature increases, gradually at first, and then suddenly to *~3 million degrees*.

So here is an astronomer who honestly and openly worries not only why the lower corona has such a high temperature but also why the corona even exists in the first place. He is correct to worry. A purely non-electrical nuclear fusion reaction that is confined to the Sun's central core would not produce an electrical corona discharge far above its surface.

The Electric Sun Model Predicts the Temperature

Minimum

The ES model predicts the temperature discontinuity. Here's how. Charged particles do not experience external electrostatic forces when they are within the photosphere. Only diffusion motion (response to a concentration gradient) and random thermal (Brownian) movement occurs. Temperature is simply the measurement of the violence of random movements. The photosphere is where the Sun's ~5800 K surface temperature is measured. The energy plot in figure 10 shows that positive ions have their maximum ***electrical potential energy*** when they are in this photospheric plasma. But their ***mechanical (kinetic) energy*** (temperature) is relatively low. At a point just to the left of the right hand edge of the photospheric plateau, any random movement toward the right (radially outward) that carries a + ion even slightly over the edge will result in its being swept away, down the energy hill, toward the right. Such movement of charged particles due to an electric ***E***-field (voltage gradient) is called a 'drift current.' This drift current of accelerating positive ions forms the main constituent of the solar wind.

As positive ions begin to accelerate down the steep potential energy drop, they convert the high (electrical) potential energy they had in the photosphere into kinetic energy – they gain extremely high outward radial velocity and lose side-to-side random motion. They become 'dethermalized.' In this region between the upper photosphere and lower chromosphere, the movement of these ions becomes extremely organized (parallel). Thus their temperature, which is a measure of their random motion, drops to a minimum.

When these rapidly traveling + ions pass into the transition zone at the chromosphere, they move beyond the intense outwardly directed ***E***-field force that has been accelerating them. They have reached the bottom of the hill and are moving much faster than when they were at the top. Because of their high kinetic energy, any collisions they have at this point are violent and create high-amplitude random motions, thereby 're-thermalizing' these ions to a much higher temperature. The sparkling x-ray emissions that have been observed in this region are due to collisions of the accelerated ions coming from the photosphere.

Ions just above (in the diagram, to the right of) the transition region are reported to be at temperatures of one to two million K. Nothing else but exactly this kind of result could be expected from the Electric Sun model. The re-thermalization takes place in a region analogous to the turbulent white water that boils up at the bottom of a smooth laminar water slide. In the fusion model, no such (water slide) phenomenon exists – and therefore neither does any simple explanation of the temperature discontinuity.

The Electric Sun model accurately predicts this temperature profile and shows why it occurs. In fact, if there were no temperature discontinuity, this would pose a problem for the Electric Sun hypothesis.

Acceleration of the Solar Wind

The positive ions that are the major constituent of what astronomers call the solar wind move faster the farther away from the Sun they get. The positively charged ions of the solar wind accelerate outward through the corona and beyond. The electrons seem to mill around with no preferred direction. Any given volume is essentially neutral – having equal numbers of + and – charges.

Nothing in the fusion model predicts or explains this observed phenomenon. Streams of neutral gas do not behave in this manner. Winds do not normally accelerate all by themselves. Some astronomers have postulated that photons leaving the Sun collide with the ions and accelerate them. But a 'postulation' is not an explanation. Dr. Peter T. Gallagher of the Big Bear Solar Observatory presented a seminar on Observations and Modeling of the Corona and Solar Wind in which he said:

> "***Understanding the physics of coronal heating and solar wind acceleration remains one of the unsolved problems of solar physics.*** It is believed that the corona is heated by either high frequency MHD waves or by many small scale reconnections, but the exact heating mechanisms and how they relate to the acceleration of coronal plasma are still uncertain." [Emphasis added.]

In this quote, we see the invocation of magnetic reconnection as a possible mechanism. In a later chapter, we will examine how impossible this 'magnetic reconnection' process is.

Any student of physics who has studied electric charge and electric fields knows that the easiest way to get electrically charged particles to accelerate is to apply an electric field to them. Let them fall through a voltage drop from one region to another. The acceleration of the positively charged solar 'wind' particles is clearly an electrical phenomenon. The Electric Sun model accurately predicts its existence and explains its cause.

Critics of the Electric Sun hypothesis have claimed that electrons (negative charges) are also accelerated away from the Sun, and therefore, the acceleration of the solar wind cannot be an electrical effect. They propose that photons of the Sun's light hit ions and electrons and thus accelerate them.

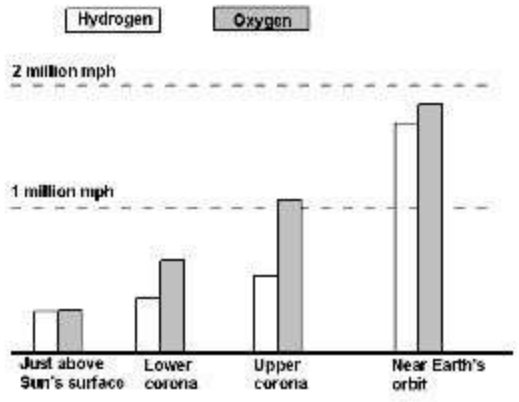


Figure 12: Ionic velocities in the solar wind.

Whether this is the case or not is still unclear. Although data on positive ion acceleration such as that shown in figure 12 is readily available, I was not able to find equivalent specific data on electron velocities at similar distances from the Sun. This point remains controversial.

What needs to be obtained is data on electron density ***and average velocity*** at a point as close to the Sun as possible and then at another point at least as distant as the orbit of Jupiter. Only when such information is reliably available can decisions be made about the validity of this aspect of the proposed Electric Sun solar model.

Cosmic Rays

The ES model also explains the origin of cosmic rays. After leaving the Sun's neighborhood, the particles in our solar wind eventually join with the spent solar winds of all the other stars in our galaxy to make up the total 'cosmic ray flux' in our arm of our galaxy. The Sun is at a higher voltage level than is interstellar space beyond the heliopause, the outer boundary of the Sun's plasmasphere. Cosmic rays are made up of solar wind particles ejected from the heliospheres of the stars.

The Sun is a rather mediocre star as far as radiating energy goes. If it is electrically powered, perhaps its mediocrity can be attributed to a relatively unimpressive driving potential. This would mean that hotter, more luminous stars should have driving potentials greater than that of the Sun and thus should expel cosmic rays of greater energies than solar cosmic rays.

A star with a driving potential of, say, twice that of the Sun, 20 billion volts, would expel protons energetic enough to reach the Sun's surface, arriving with 10 billion electron volts of energy to spare. Such cosmic ions, when they collide with Earth's upper atmosphere, release the mu-type neutrinos that have been in the news recently.

Hannes Alfvén said about cosmic rays: "How these particles are driven to their fantastic energies, sometimes as high as a million billion electron volts, is one of the prime puzzles of astronomy. No known (or even unknown) nuclear reaction could account for the firing of particles with such energies; ***even the complete annihilation of a proton would not yield more than a billion electron volts***." [Emphasis added.]

Transistor Action at the Solar Surface

To an electrical engineer, the single most interesting thing to notice about the plot of electrical potential energy presented in figure 10 is that it is ***identical to the plot of energy (V) found in a solid-state pnp transistor***.

In a transistor, the amplitude of the 'collector current' (analogous to the outward radial drift of +ions in the solar wind) is easily controlled by raising and lowering the so-called 'base – emitter voltage.' In figure 10 this voltage is the difference between the voltage level of the Sun's interior up to that in

the photosphere. So is this same mechanism (a voltage difference between the Sun's interior and its photosphere) controlling the strength of the solar wind?[76] It appears that the answer is yes.

For example, if the Sun's interior voltage were to decrease slightly, say because of an excessive flow of outgoing +ions or incoming electrons, the voltage barrier from the interior up to the photosphere would increase in height and thus reduce the solar wind flux (both the inward electron flow and the outward +ion flow). This is a self-regulating effect because the excessive loss of +ions will be clamped off by the increased barrier height.

A sufficiently high value of this voltage can cut off the collector current altogether. These two mechanisms (the solar wind and the ***pnp*** transistor) appear to be analogs of one another. In May of 1999, the solar wind completely stopped for about two days. There are also periodic variations in the solar wind. The transistor-like mechanism described above is certainly capable of causing these rapid fluctuations. It also makes clear their cause – fluctuations in the solar surface voltage distribution.

The fusion model is at a complete loss to explain rapid fluctuations in the solar wind. It certainly cannot explain why it entirely ceased for two days.

During the years from 1645 through 1715, few if any sunspots were observed. This period is called the Maunder Minimum. Maunder (1890, 1894) pointed out that this lack of sunspots apparently coincided with an absence of terrestrial auroras. This suggests that electrical solar activity was greatly reduced over this seventy-year time span, another example of an electrical effect on the Sun.

Helioseismology

We have heard much recently about the successes of helioseismology. It should be noted that the science of ***geo***-seismology (e.g., the process of finding underground oil deposits) is an *active* process. A downward shock wave is initiated and the reflected sound is analyzed. In the past, an explosive charge was used to send the shock (sound) wave down into the ground. More recently, mobile 'sounder units' that utilize large panels placed on the ground or inserted into deep wells perform this function.

With another technique, seismic tomography, researchers get images that

provide information on fracture locations, the continuity and thickness of rock layers, and other structural features. This method involves a high-frequency (over 3,000 Hertz) mechanism in which the velocities of seismic waves are measured using multiple pairs of boreholes. In each borehole pair, the source of the seismic signal is placed in one hole, the seismic sensors are placed in the other, and signals are measured as they cross the ground between source and receiver holes. The procedure then becomes similar to the use of x-rays to obtain a CAT scan of the human body. Signal data is recorded from multiple points and a computer is used to reconstruct a composite 3-D image.

However, solar helioseismology is a ***passive*** process. There is no way to 'shock' or 'probe'[77] the Sun. We simply listen to the ongoing low-frequency variations in the light that the Sun emits. It is not a cause-and-effect experiment. The main tool is observation of Doppler shifts in the lines of the Sun's spectrum. These shifts are supposedly due to up and down oscillations of the surface. The observational goal is to measure shifts of a spectrum line to an accuracy of parts per million of its width. Solar astronomers claim their models of the Sun's interior afford precisely accurate correspondence with observed oscillations. But these complicated models were developed ***after*** the oscillations were measured.

The analysis of these passive signals is much more open to interpretation than are the results of active geo-seismology. How much underground oil would geologists discover if their only tool for doing so was to sit and listen passively to the rumblings of distant earthquakes? That is essentially what helioseismologists are doing – because it is all that they ***can*** do.

Many Questions Are Answered by the ES Model

Why does the Sun rotate faster at its equator than at higher latitudes? This is yet another question for which the standard model has no answer. In fact, why does it rotate at all? As we will see in an upcoming chapter, the homopolar motor mechanism proposed by Thornhill, and indirectly proposed by Alfvén, predicts exactly this kind of behavior. This device uses an electric current and a magnetic field to produce rotational motion.

The question, "Are there enough electrons approaching[78] the Sun to

power it?" is a legitimate one. In an article, *Electric Discharge as the Source of Solar Radiant Energy,* compiled from Juergens' notes by the late Earl R. Milton, Professor of Physics at the University of Lethbridge in Canada, Juergens (and Milton) made a quantitative derivation that concludes the answer is yes.

So, the founders of the Electric Sun hypothesis claim that there ***are*** sufficient electrons out there to power the Electric Sun. Critics of the ES model point out that a flow of electrons into the Sun has yet to be observed. But all the measurements we have made (with one major exception) have been close to the Sun's equatorial plane. The exception occurred in the spring of the year 2001, when the spacecraft Ulysses discovered long plasma 'tubes' (i.e., Birkeland currents) reaching to the south pole of the Sun from a distance as far out as Mars.

Astrophysicists do not seem eager to look for the kind of electron flows that the ES model predicts should be there. If they are not trying to discover them, it is easy not to see them. We eagerly wait for an announcement of what sort of currents (or 'winds,' as astrophysicists will call them) are found in those long flux tubes that enter the south (and probably the north) polar region of the Sun.

The Sun seems to have a fairly stable, although not entirely constant, power output. As the Sun travels around the galaxy, it may come into regions of higher or lower total current, and so its output may vary both periodically and randomly.

Why doesn't the Sun collapse of its own weight? How can we account for the fact that the Sun has been around for a long time with approximately the same luminosity yet has not collapsed in upon itself? In orthodox theory, a main-sequence star such as the Sun behaves like a ball of gas, with temperature and pressure both increasing from the outer surface toward the center. The temperature is needed to sustain the pressure, and the pressure is needed to fend off gravitational forces, which in the absence of sufficient pressure would lead to collapse. In Juergens' theory, with no fusion going on in the core, how can a flat internal temperature gradient maintain sufficient pressure to resist collapse?

The answer is best stated by Thornhill:

> The electric star model makes the simplest assumption – that nothing

> is going on inside the Sun…. [In the plasma that makes up the Sun] the nucleus of each atom, which is thousands of times heavier than the electrons, will be gravitationally offset from the centre of the atom. The result is that each atom becomes a small electric dipole. These dipoles align to form a radial electric field that causes electrons to diffuse outwards in enormously greater numbers than simple gravitational sorting allows. That leaves positively charged ions behind which repel one another. That electrical repulsion balances the compressive force of gravity without the need for a central heat source in the star. An electric star will be roughly the same density throughout, or isodense.

We should remember that the strength of the electrostatic attraction force between a proton-electron pair is something over 39 orders of magnitude greater than the strength of gravitational attraction. (Not 39 ***times*** but 39 ***orders of magnitude –*** a multiplier of one followed by 39 zeroes). So the necessary offset of the electron from the nucleus can be sub-microscopic and yet produce an extremely strong electrical force to counteract gravitational collapse.

The Sun does not require internally generated heat in order to avoid collapse. The Electric Sun hypothesis deserves serious investigation because it answers a multitude of questions and enigmatic observations that the standard model cannot. Of course there is the question of where do these electrical currents come from? Granted that stars are powered by electricity, where does the input come from? – The short answer is – we do not know. We do know that there are vast, hugely powerful streams of charge (electric currents) moving throughout intergalactic space. They might be the result of relative movement between plasma and magnetic fields, or there may be some monstrous voltage difference between two points in the super-universe. We just don't know.. But there is no shame in admitting this. It is more honest to admit ignorance than to invent a ‘hidden dynamo’ to explain it all.

Image by the author.

Plate 4: The Bubble Nebula (NGC 7635). This spherical plasma cell is about 70 light-years from Earth.

Chapter 11

The Sun's Electrical Atmosphere

What causes sunspots and those bubble-like coronal mass ejections (CMEs)? How about the magnificent coronal loops and holes that dwarf Earth? Why do the outer regions of the corona appear to be 'stringy'? Are there electrical mechanisms at work in these gigantic phenomena – or can they be explained by the standard model?

Plasma Modes Revisited

Earlier we described the three characteristic modes in which plasma can operate. Let us take a more detailed look at these modes and relate them to what we observe on the Sun.

Here again the analogy of water flowing in a river is helpful to our understanding. At any point within the stream, the most significant measurement is the flow ***density*** (in gallons per minute per unit cross-sectional area of the flow). If we sum up the flow density for every square meter of cross-sectional area, we can determine the total flow (in gallons per minute) of the river.

We realize that the flow density is probably strongest at some point in the middle of the river, far from shore and not near the bottom. And if our river gets wider, the flow density at each sample point in the flow will decrease (same total flow – bigger total cross-sectional area). That of course, is why rivers are usually shallow near their mouths – the reduced flow density allows suspended matter to sink to the bottom and form a delta. The slope of the river bottom necessary to produce a river's flow can be measured in feet (of drop) per mile.

Electric current (Amps) is analogous to the flow (gallons per minute) of the water,[79] and the electric field (Volts per meter) is analogous to the steepness of the drop of the river bottom (feet per mile) at any point along its path.

Let's plot a graph. The downward slope of the river bottom (in feet per mile) on the vertical axis – on the other axis we will plot flow density (in

gallons per minute per square meter of flow cross-section). At a point on the graph where the drop of the river is quite steep, the flow will be large. The plot may not be a straight line, i.e., it may be 'non-linear.'

We are interested in the motion of charges (electric current flow) within a plasma. Let us plot potential energy drop (in Volts) vs. current density (in Amps/m^2). Such a plot is directly analogous to the plot describing the flow of water in the river.

The plot in figure 13 was measured in a laboratory plasma contained in a column – a cylindrical glass tube with the anode (high voltage point) at one end and the cathode (low voltage point) at the other. In the lab, the strength of the current passing through the plasma can be carefully controlled.

The vertical axis of the plot in the figure is the voltage drop measured across the plasma. The horizontal axis shows the current density flowing in the plasma (strength increasing from left to right). The shape of the curve tells us the resulting voltage that will be measured from one point to another within the plasma as a function of how much current we force through the plasma. The first thing we notice is that the plot is highly nonlinear (no straight lines here). It is also broken into three distinct sections. These define the three distinct modes of operation we mentioned earlier.

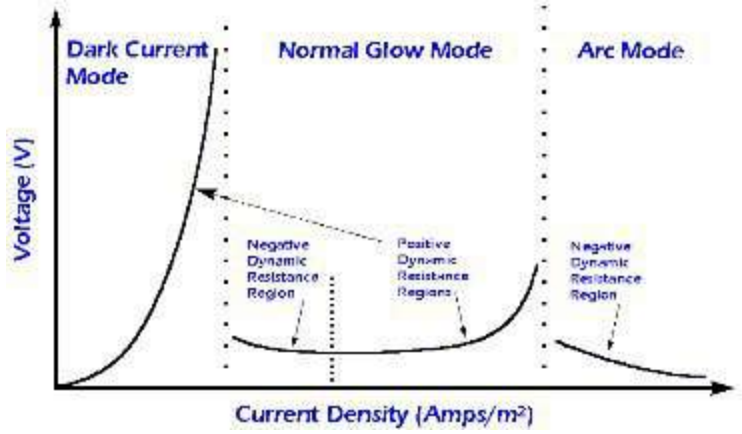


Figure 13: The Volt-Ampere plot of a plasma discharge.

Examine the plot carefully. In the dark current mode shown on the left, if we increase the current density through the plasma, a higher voltage will result across it. But if a sufficiently high level of current density is pushed through the plasma, the voltage will drop abruptly and the plasma will light up in the

normal glow mode of operation. If we continue to raise the current density, another (less steep) rise in voltage will be followed by another abrupt drop – the plasma will jump into arc mode. This plot reveals many of the 'mysterious' properties of plasma.

In the cylindrical tube typically used in the laboratory, the cross-sectional area is the same size at all points along the tube. These circular cross-sections are like salami slices cut through a cylindrical shaped sausage. Therefore the current ***density*** (Amps/m^2) is the same at every cross-section along the length of the plasma.

When we consider the Sun, however, a spherical geometry exists – we have a spherically shaped plasma with the anode Sun at its center. The cross-section through which the current flows in this plasma is an imaginary spherical surface – not a circular slice taken through a cylinder.

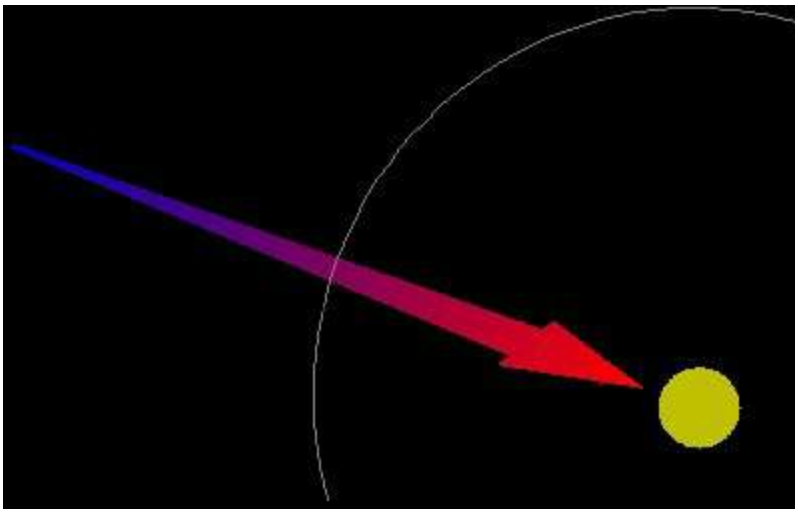


Figure 14: The Operating Modes of the Solar Plasma

Imagine this spherical surface as having a very large radius. The fixed amount of total current passes through it. But since the surface area of this imaginary spherical cross-section is so large, the total current results in only a very few Amps flowing through each square meter of that surface. Current ***density*** is low.

As we approach the Sun, the spherical surface will have an ever-decreasing area. Therefore, for a fixed total current (A), the current density (A/m^2) increases as we move in toward the Sun. In deep space (where the imaginary sphere has an extremely large surface area), the current density is

extremely low even though the total current may be huge. Therefore we are in the dark current mode (see the left side of figure 14). It does not glow and we have nothing to tell us we are in a plasma discharge – except possibly some radio-frequency emissions. We are in the leftmost section of figure 13 too. Moving inward from deep space toward the Sun is equivalent to moving from left to right in both figure 13 and figure 14.

As we get closer to the Sun, the imaginary sphere has an ever-smaller surface area, the current density continues to increase, and we soon enter the normal glow region of the plasma. This is what we call the Sun's 'corona'. The characteristics of the radiated light are much like those of a neon sign.

As we approach still closer to the Sun, the spherical surface gets to be only slightly larger than the Sun itself, the current density becomes extremely large, and we enter the arc region of the plasma. This is the photosphere, the region of anode tufts. The characteristics of the radiated light are much like those of an arc-welding machine: intense ultraviolet light and intense radio frequency noise are emitted.

Now, consider what would happen if the Sun's diameter increased. Assume the ***total*** current remains a fixed quantity. The Sun's surface could lie entirely outside the arc mode boundary. No plasma tufts will form. (Decreasing the total current would reduce the current density at the Sun's surface and produce the same effect.) Such a Sun would not have a photosphere.

This demonstrates why we can say that a photosphere (plasma arc mode tufting layer) covers any star that is too small relative to the intensity of the electric current impinging on its surface.

We have already mentioned that some early plasma researchers and most modern astrophysicists believe that plasmas are perfectly conductive and so will 'freeze' magnetic fields within them. The plot of plasma voltage vs. current density (figure 13) demonstrates that this cannot happen. Every point on the plot (except the origin) has a non-zero voltage coordinate. In other words, it takes a small electric field within a plasma (no matter what mode it is in) to maintain it. No matter which mode it is operating in, a plasma is not an ideal conductor.

Another way of seeing this is to examine the resistivity of plasma. The ***static resistivity*** of a plasma operating at any point in figure 13 is equal to the slope of a straight line drawn from the origin of the plot out to that point. This

means that, in every possible mode in which a plasma can operate, it has, in all of them, a non-zero static resistivity. A non-zero-strength ***E***-field is necessary to produce the current density. For example, in figure 13 we can see that the static resistivity of a plasma in the high end of the dark current mode can be fairly large. In the arc mode, static resistivity is typically extremely low – but not zero. The highest conductivity (lowest static resistivity) plasmas are those operating in the arc mode. But even in that mode, any current density, no matter how small, requires a non-zero-valued electric field. No plasma is an 'ideal conductor.' The notion that magnetic fields must be frozen into plasmas requires that those plasmas be ideal conductors. They are not. Therefore, magnetic fields are not frozen into plasmas.

Filamentation

We have mentioned several times that the formation of filaments ('strings') is natural in plasmas. In figure 13, the slope of the plot at each given point is the ***dynamic resistance*** of the plasma at that location. The entire arc mode region exhibits ***negative dynamic resistance***. So does the leftmost (low-current-density) region of the normal glow mode. This negative dynamic resistance causes the filamentary behavior first noted by Birkeland.

Alfvén describes[80] the negative slope of the volt-ampere plot as being "a 'falling characteristic', by which we mean that the electric field necessary to maintain the discharge is a decreasing function of the current density. If the total discharge current is a constant, the electric field strength is smaller when the current is concentrated in a small channel than when it fills the whole [cross-sectional] space. A discharge often adjusts itself so that the electric field strength becomes a minimum." For example, at a point within the low current density region of a normal glow discharge, the current tends to bunch together (form filaments) in order to *raise* the current density at that point.

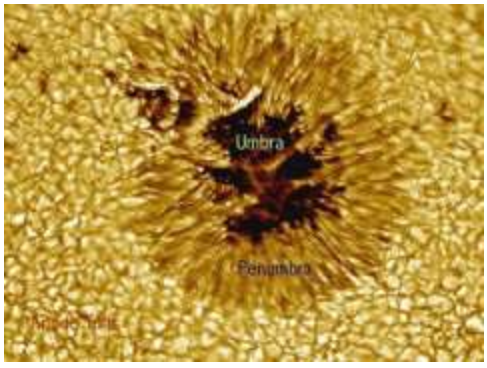
Filamentary structures are often observed in the cosmos – in the outer solar corona, prominences, sunspot penumbrae and photospheric tufts, as well as in interstellar clouds, comet tails, and strings of galaxies. This inherent tendency to produce filaments – strings – is a well-known and easily explained fundamental property of plasmas. Not only the existence of the

Sun’s corona but also the structure of stringy filaments in its outer regions are obvious electric plasma phenomena. These characteristics have been measured in laboratories for decades.

Fusion on the Solar Surface

The z-pinch effect of current filaments in arc mode plasmas is very strong. The effect in the filaments of the Sun’s photosphere would be strong enough to fuse atoms. Whatever nuclear fusion is taking place on the Sun is likely occurring in the double layer (DL) above the top of the photosphere, not deep within the Sun’s core. The products of this fusion process are the ‘metals’ that give rise to absorption lines in the Sun’s spectrum. (Astronomers call any element heavier than helium a ‘metal.’) Traces of sixty-eight of the ninety-two natural elements are found in the Sun’s atmosphere. We will discuss stellar spectral lines in detail in a later chapter.

The question of where these heavy elements come from in a totally fusion powered Sun is not easily answered. According to standard theory, the interior of the Sun consists solely of the fuel (hydrogen) and its byproduct (helium) in a variety of their isotopes – and nothing else. The usual explanation offered by theoreticians for the presence of the metals is that all these other elements are generated in supernovae (exploding stars) and the resulting dust is sprinkled throughout the universe. Then our Sun was formed from this metal-enriched dust.



Credit: Vacuum Tower Telescope, NSO, NOAO

Figure 15: A sunspot showing the umbra, penumbra, and surrounding tufts.

The Electric Sun (ES) model offers a more realistic answer. The ES model

avoids such *ad hoc* explanations. The electric power that is delivered to any point in the plasma sur-rounding the Sun is the product of the value of the ***E***-field (in Volts per meter) times current density (Amps per square meter) at that location. This multiplication yields power density (Watts per cubic meter). The current density is relatively constant over the height of the photospheric–chromospheric layers.

However, the ***E***-field is by far strongest at the center of the DL. Because nuclear fusion takes a great deal of power, the creation of metals most likely takes place there. The products of this fusion produce the observed spectral absorption lines.

Sunspots

In an arc mode plasma, both the dimensions and the voltages of the anode tufts depend on the current density. The tufts appear and disappear as needed to maintain a required relationship between +ion and electron numbers in the total current. This property of anode tufts was discovered, quantified and reported by Irving Langmuir over fifty years ago. In the Electric Sun model, as with any plasma discharge, tufting disappears wherever the current density impinging onto a given area of the Sun's surface is not sufficiently intense to require the shielding produced by the plasma double layer.

At any such location, the anode tufting collapses and we can see down toward the actual anode. Since there are no arc discharges occurring in these locations, they appear darker than the surrounding areas and are termed 'sunspots.' The fact that sunspots are dark and cool strongly supports the contention that little, if anything, is going on in the Sun's interior.

The neutrino flux from the Sun seems to vary inversely with sunspot number. This is not unexpected in the ES hypothesis because the source of those neutrinos is the z-pinch-produced fusion occurring in the double layer (DL) – and sunspots are locations where there is no DL in which this process can occur.

Sunspots are places where tufting is not occurring. They are holes in the photosphere and therefore places where we can see deeper into the body of the Sun. The temperature of a sunspot's umbra (its dark center) is typically around 3800 K to 4000 K. This is 2000 K lower than the temperature of the photospheric surface itself, which is approximately 5800 K. If energy is

really flowing upward toward the surface of the Sun from a 6 million K core, these holes in the photosphere should be much hotter than the outer layers of the photosphere, not cooler. The standard speculation for this phenomenon – the low temperature of umbrae – is that 'strange magnetic waves' and 'tangled' magnetic fields below the surface must prevent heat energy from flowing up at these points.

Because there is no anode tufting where a spot is located, the voltage barrier presented by the photosphere that normally limits the flow of positive ions leaving the interior of the Sun does not exist there. Above the umbrae, the energy (voltage) plot[81] falls smoothly downward from its intersection with the vertical axis (its level within the Sun) toward the horizontal axis (the voltage level of the lower corona).

In sunspots – where that barrier has been removed – a large number of ions will flood outward toward the lower corona. Such a flow represents a large electric current that will produce a strong localized magnetic field around the sunspot.

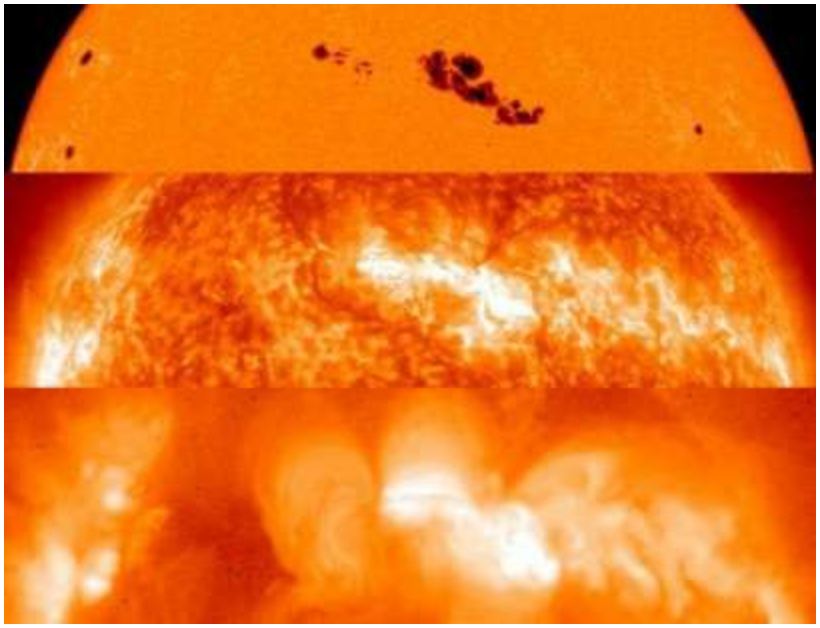
Because the corona is a normal glow discharge, it is difficult to see it against the much brighter tufts that are in arc mode. But the corona's higher temperature makes it emit strong x-rays, enabling us to see its structure in x-ray images.

The bright regions in x-ray images of the corona indicate hotter, more energetic areas. These are found above sunspot concentrations. In the three images of a sunspot group shown in figure 16:

- The top one is the photosphere – taken in visible light. In the sunspots, ions are pouring upward out of the Sun.
- The middle image is taken in ultraviolet light and shows the chromosphere–transition region. Brighter regions correspond with sunspot locations.
- The lower panel is an x-ray image. The flood of accelerating positive ions escaping from sunspots is colliding with atoms in the corona and is emitting x-rays. In some x-ray images of the Sun, we can see 'coronal holes' – large dark regions. At times of lower solar activity (sunspot minima), the holes spread over most of the corona and (in x-ray) it 'switches off.'

Another obviously electrical phenomenon on the Sun's surface is the

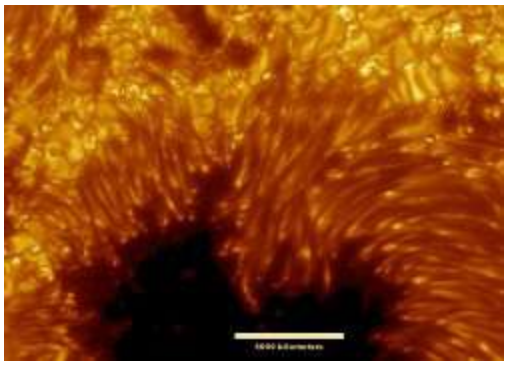
penumbrae of sunspots. The penumbrae are those regions that form between the usual tufted photospheric surface and the dark central umbrae of the spots. They consist of swirls of filaments that have all the characteristics of Birkeland currents. Thus nuclear fusion may occur within them. However, the size of the voltage drop from the Sun's interior down to that of the inner corona that drives these plasma filaments is less than the voltage drop that exists in the DLs above the normal tufts. Thus, it is logical to conclude that more (or at least different) fusion products are being released from the normal tuft DL regions than from these penumbral filaments.



Credit: SOHO - MDI / EIT Consortiums, Yohkoh / SXT Project

Figure 16: Top – the photosphere; Middle – the chromosphere; Bottom – the lower corona.

Recent images of penumbrae (shown here as figures 17 and 18) reveal the twisting filaments that the ES model predicts must occur there. Researchers at the Royal Swedish Academy of Sciences in Stockholm, led by Goran Scharmer, discussed the new images in the November 14, 2002, issue of the journal *Nature*. Team member Dan Kiselman wrote: "A dark-cored filament looks like a glowing snake with a dark stripe painted along its back. The 'head' of the snake is often a complicated feature where the stripe splits up among many bright points."



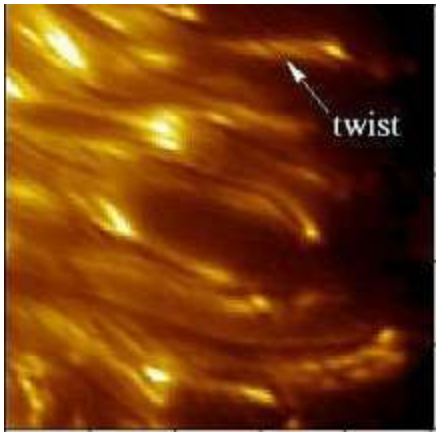
Credit: SST, Royal Swedish Academy of Sciences

Figure 17: The Penumbral filaments or ‘streamers.’
To scientists familiar with electric plasma dis-charges, the streamers look like Birkeland currents.

Solar Plages

Solar ‘plages’[82] are bright cloud-like features found ***near sunspots*** that represent regions of higher temperature and density within the chromosphere. They exhibit absorption lines characteristic of the presence of helium. The presence of helium clouds near sunspot penumbrae is consistent with the probability of hydrogen → helium fusion occurring in sunspot penumbrae as described in the previous section.

Omega Loops and CMEs



Credit: SST, Royal Swedish Academy of Sciences

Figure 18: Twisting Birkeland currents in the filaments.

The above discussion applies to the near-steady-state operation of the Electric Sun. But there are several dynamic phenomena such as flares, prominences, and coronal mass ejections (CMEs) that we observe. How are they produced? Prominences are plasma features that may reach high into the corona, often as graceful loops that may hang suspended for many days.

Hannes Alfvén, although not aware of the Juergens Electric Sun model, described[83] a theory of how prominences and solar flares are formed electrically.[84] It is consistent with the Juergens model. Alfvén's circuit is shown in figure 20.

Any electric current creates a magnetic field (the stronger the current, the stronger the magnetic field and the more energy it contains). Curved magnetic fields only exist in the presence of either electric currents or time varying electric fields. If the current is inter-rupted, the magnetic field collapses and its energy must be delivered somewhere. In fact Alfvén states explicitly that certain phenomena ***cannot be understood*** without referring to electric currents. Among these are the formation of double layers and the occurrence of explosive events such as stellar and solar flares.

Credit: M. Aschwanden et al. (LMSAL), TRACE, NASA.

Figure 19: Trace image of coronal plasma loops.

Sometimes a magnetic field on the surface of the Sun forms an 'omega' shaped loop. This loop extends out through the double sheath layer (DL) of the chromosphere.

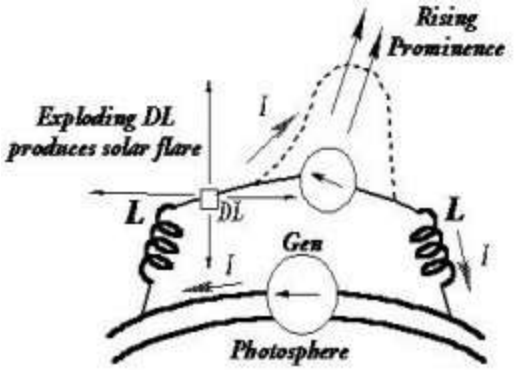


Figure 20: Hannes Alfvén's Solar Prominence Circuit.

One of the characteristic properties of Birkeland currents is that they generally follow the direction of a magnetic field. We cannot see magnetic fields, but we often ***do*** see material that has been collected by the z-pinch effect of currents that are following a magnetic field. That material radiates energy – it is plasma in either the glow or arc mode of operation. Thus, in figure 19, we are not directly seeing the magnetic omega loops, we are seeing the glowing plasma concentrated into filaments by currents that follow those loops.

A strong looping current will produce a secondary doughnut-shaped magnetic field that will surround and try to expand the loop. If the current following the loop becomes too strong, the DL that it contains will be destroyed. If the voltage gradient becomes strong enough to rip all charges away from an area, the discharge path will break. This interrupts the current similarly to opening a switch in an inductive circuit, and the energy stored in the primary magnetic field is explosively released into space.

Inductance is a property of some electric circuits that is akin to the property of inertia in the flow of a fluid. Suddenly stopping the flow will result in a strong force. If a fully running faucet is abruptly turned off, we may hear a loud knock in the pipe. This effect is known as a 'water hammer.' Similarly we cannot easily halt extremely intense electric currents. Trying to break the circuit through which such a current is flowing often results in the refusal of the current to stop – it may jump the gap in an explosive arc discharge. These spectacularly damaging displays in high voltage electric power systems were the phenomena that originally prompted Alfvén's interest in plasma research.

Alfvén said, "If a current flows through an electrostatic double layer

(which is often produced by the current itself), ***the layer may cut off the current***. This means that the voltage across the double layer may reach the value necessary to break the circuit (in the laboratory, say 10^5 or 10^6 V; in the magnetosphere, 10^4-10^5 V; in solar flares, even 10^{10} V). The plasma explodes, and a high-vacuum region is produced."[85]

Electric Currents beneath the Sun's Surface

In a later chapter we will discuss Hannes Alfvén's proposed electric star circuit. In his model, electric current passes through both poles of the star. It then flows in long tubes emanating from the star. A secondary leakage current that flows on or just below the Sun's surface, back ***toward the equator from each of the poles***, can explain another one of the 'mysteries' the Sun poses for solar astrophysicists.

It is highly likely that such a current system has already been discovered. Stanford University recently announced,[86] "Scientists using the joint European Space Agency (ESA)/NASA Solar and Heliospheric Observatory (SOHO) spacecraft have discovered 'jet streams' or 'rivers' of hot, electrically charged gas (plasma) flowing beneath the surface of the Sun. They also found features similar to 'trade winds' that transport gas beneath the Sun's fiery surface." Rivers of plasma are electric currents. Currents cause magnetic fields.

We have just discussed the coronal loops – omega shaped arches in the Sun's magnetic field that extend up out of the photosphere into the lower corona. Eugene N. Parker correctly calls the coronal loops 'bulges' in the Sun's magnetic field. He states:[87] "The bulges emerge through the surface of the Sun, forming bipolar magnetic regions, or magnetically active regions, with lengths up to 200,000 km. The bipolar fields have ***opposite signs on opposite sides of the equator***, and ***the algebraic signs of the fields reverse from one 11-year [sunspot] cycle to the next***." [Emphasis added]

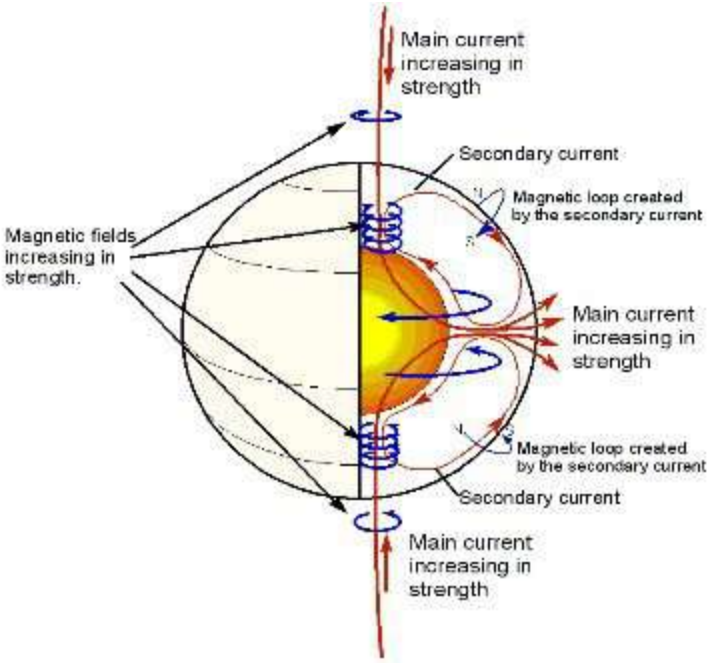


Figure 21: Primary and secondary electric currents in the Sun.

Figure 21 shows a possible explanation of this phenomenon. According to Alfvén's stellar circuit, the main solar electric current flows into (or out of) each pole of the Sun. Making use of the 'right-hand rule,'[88] we can visualize the directions of the encircling magnetic fields created by that current. If the strength of this current is increasing, the magnetic field will strengthen as well. Such time varying magnetic fields can induce secondary currents[89] as shown in the figure. The secondary current will only exist when the magnitude of the linking magnetic field is growing or shrinking. This effect is utilized here on Earth in AC transformers and so is called *transformer action*.

If a secondary current filament is flowing southward from near the Sun's north pole and it is on or just beneath the Sun's surface, a looping magnetic field will emerge to the east of the current creating a north magnetic pole there. (Right thumb directed toward the south, fingers emerging up out of the surface on its east side.) The loop will move out above the Sun's surface and then return down into the surface forming a south magnetic pole to the west of the current. Recall that a 'north magnetic pole' is a region where the magnetic flux emerges ***from*** a solid.[90] In the Sun's southern hemisphere, the secondary surface current is flowing northward toward the solar equator. The

resulting magnetic field will emerge (north magnetic pole) to the west of the current and return down to the surface (forming a south magnetic pole) to the east of the current. Thus the action described by Parker ("The bipolar fields have opposite signs on opposite sides of the equator.") follows directly from Alfvén's circuit. Of course, the locations of the subsurface currents shown in figure 21 are speculative at this point. But these reversing magnetic fields provide a classic example of a phenomenon that cannot be understood without reference to the electric currents that produce it.

Subsurface Currents Cause Magnetic Reversals

Regardless of the direction of the main driving current coming into the Sun, the eleven-year reversal of the magnetic loops can be explained by transformer action. If the main magnetic field that induces the surface currents is growing in strength, the surface current will point in one direction. If the main magnetic field starts to weaken in intensity, the secondary (surface) current ***will reverse direction.*** Consequently the magnetic polarity of the loops will also reverse. Notice that this mechanism does not require the main solar driving current itself to reverse direction, only to vary in amplitude. It also does not depend on the direction of the primary current.

On June 3, 1999, the European Space Agency announced that the Sun's magnetic field is getting progressively stronger. Thanks to the unprecedented overview of solar magnetism provided by the ESA-NASA spacecraft Ulysses, a team at the Rutherford Appleton Laboratory near Oxford has been able to work out the recent history of the Sun's magnetic behavior. According to calculations by British scientists, the strength of the Sun's magnetic field has doubled during the Twentieth Century alone. This finding may help to clarify the Sun's contribution to climate change on Earth. The hydrogen → helium fusion model does not explain this phenomenon.

Questions Yet to Be Answered

Although we have seen that the Electric Sun model explains many of the puzzles that standard solar models cannot, there are many questions still to be investigated.

- What is the exact circuit diagram? – Precisely what paths do the

galactic currents take in the vicinity of the Sun?

• Will the solar charge be replenished over time by cosmic ions (‘rays’)? Do incoming cosmic rays help power the Sun? Will the Sun’s radiative lifetime extend only until the solar charge (and therefore, its voltage) equals that of its galactic surroundings? Incoming cosmic ray protons, which bombard Earth and the Sun, represent currents (solar ‘winds’) from higher-voltage stars that liberate positive ions with sufficient energy to overcome the Sun’s repelling voltage and impinge on its surface. Is this mechanism, by which the Sun is able to regain some positive charge, of significance in extending its ultimate lifetime?

• We know that currents or time-varying electric fields are necessary to produce the Sun’s strange and changing magnetic fields. Magnetic fields cannot exist without electric currents. Are the magnetic field reversals observed on the Sun due to variations in the intensity of galactic currents or ***E***-fields through which the Sun is traveling? Or is the Sun simply traversing current streams of slightly different strength? (Are we making ‘lane changes’ on the superhighway of galactic electric current flow?) Is the Sun ‘surfing’ across a galactic series of Birkeland currents – or are we locked onto a single somewhat bumpy one-lane road in space?

• The Sun is a typical star – if the Sun is primarily an electrical entity, then so must be all the stars. Is the Electric Sun model consistent with what we know about stars in general? Are we, in reality, discussing the ***Electric Star Model***? The answer is, of course, yes. We will discuss this model in another chapter.

Some Results

This chapter has presented a summary of Ralph Juergens’ Electric Sun model and mentioned several extensions that others and I have proposed. Our Sun ***may*** be totally powered by the subtle currents that move throughout the now well-known low-density plasma that permeates our galaxy. More

measurements are needed before we can draw that conclusion.

To its advantage, the Electric Sun model is relatively simple. It is self-consistent and does not require the existence of mysterious entities such as the unseen solar 'dynamo'[91] that lurks somewhere beneath the surface of the fusion model and creates impossible 'tangled magnetic fields' that produce sunspots. It does not require arbitrary adjustments, exceptions to the laws of physics, or after-the-fact speculations. It passes the Occam's razor test.

Most importantly, the Electric Sun model does not violate Maxwell's equations as the proponents of the fusion model do when they suggest magnetic field lines can open and reconnect.

Figure 22: Ralph Juergens in 1949
Ralph Juergens had the genius to develop the Electric Sun model back in the 1970s. His seminal work may eventually get the recognition it deserves. Or it may be modified or discarded.

But there is now inescapable evidence that a majority of the phenomena we observe on the Sun are ***fundamentally electrical in nature***.

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Chapter 12

Open Magnetic Fields and Other Fictions

Most people have seen drawings of the magnetic field that surrounds a bar magnet. Magnetic lines of force leave the north pole of the magnet, curve out into the surrounding space, and then circle back symmetrically so that all of them enter the south pole of the magnet. Although seldom shown, each line should be drawn through the body of the magnet and connect to its starting point. But a magnetic field is not really a set of discrete lines. The lines are drawn to indicate the direction and intensity of a magnetic field. As the intensity increases (toward the poles) the lines come close together. But the lines themselves do not actually exist in real three-dimensional space. They are simply visualization aids – illustrative abstractions.

If you put a small magnetic compass into any large magnetic field, the compass needle will point in a certain direction. If you move the compass a tiny distance in that direction, mark this new location and continue this process, you will produce a sequence of points that defines a 'magnetic field line.' Eventually you will get back to exactly where you started. These lines are always endless closed loops. They have no beginnings or ends. Engineers talk about the magnetic 'flux' as a reminder that each point in a magnetic field has a direction associated with it. But even that terminology is a bit misleading – the word ***flux*** implies ***flow***, and the field itself is not flowing.

You can demonstrate the shape of a magnet's field by first covering the magnet with a piece of white paper and then lightly sprinkling iron filings onto the paper. Each of the tiny iron particles lines up with the magnetic field, acting like a small compass. Voilá, the shape of the field becomes visible. Of course, the field itself is invisible. Close examination will show that the filings do not connect end-to-end in continuous lines, but each one is consistent with the direction of the field.

In contrast, ***electric*** fields ***do*** have beginning and end points. Electric fields begin on positive charges and end on negative charges. There are no such things as magnetic particles on which magnetic fields can begin or end.

If we draw an imaginary closed surface of any shape and size, say a sphere or cube, and place it anywhere in a magnetic field, the net sum of the magnetic flux entering this surface is zero. What goes in goes out. This relationship is symbolized in one of Maxwell's famous equations.[92]

The propositions that magnetic field lines 'open up,' 'merge,' or 'recombine' are fallacies. They result from an error (violation of Maxwell's equations) compounded on another error (the mistaken belief that the lines are real 3D entities in the first place). Again we have an example of the attempted reification of an abstract theoretical concept. Field lines are not real-world three-dimensional entities.[93]

The concept of magnetic field lines is analogous to lines of latitude. They are not discrete entities with nothing in between them – you can plot as many of them as you like. They never become knotted. They never move around. And they most certainly do not 'break,' 'merge,' 'open,' 'pile-up,' 'get tangled,' 'recombine,' or 'reconnect.' They have no intersections (with one exception described below). They do not touch each other any more than lines of latitude do. The magnetic field they are attempting to describe is a smooth ***continuum***.

Open Magnetic Fields

The proposal that magnetic field lines can break open has been mentioned in several earlier chapters. Solar astronomers describe the magnetic field of the Sun as having 'lines that extend outward, never returning to the solar surface.'

They also propose that magnetic field lines 'reconnect' as a means of transporting energy across the temperature minimum, from the solar interior out to the intensely hot lower corona. 'Reconnection' is invoked to explain how material can be ejected outward from the solar surface in Coronal Mass Ejections (CMEs). These proposals are so crucial to the accepted explanations of observed phenomena – and so wrong – that we must examine them in detail. The primary motivation for writing this book was astronomers' repeated assertions of these flawed concepts, assertions that any undergraduate EE student would immediately recognize as false.

Even though orthodox astrophysicists, in their search for 'non-thermal'

mechanisms, advocate the idea that ‘tangled magnetic loops’ somehow throw heat out into the lower corona, the question of exactly what mechanism converts thermal energy directly into magnetic fields inside the Sun and then performs the inverse operation out in the lower corona remains unanswered. (The electric currents that would have to be associated with those fields are never mentioned.) Dwivedi and Phillips[94] state it this way:

> Astronomers have implicated magnetic fields in the coronal heating; where those fields are strongest, the corona is hottest. Such fields can transport energy in a form other than heat, thereby sidestepping the usual thermodynamic restrictions. The energy must still be converted to heat, and researchers are testing two possible theories: small-scale *magnetic field reconnections* – the same process involved in solar flares, and magnetic waves.

Another statement epitomizes the errors about magnetic fields that many astronomers make:

> Beyond a few tens of solar radii, the solar wind outflow becomes faster than the Alfvén speed (a characteristic speed in a plasma) and the solar wind and frozen-in magnetic field can never contract back to the Sun. In addition, while low-altitude arcades are often observed below expanding CMEs, coronagraph observations of the high-altitude portions of the corona virtually never show evidence of magnetic structures contracting back toward the Sun. As a consequence, the only reasonable method of reducing the IMF [interplanetary magnetic field] magnitude in interplanetary space seems to be via ***reconnection*** between oppositely directed previously ***open field lines***. [Emphasis added.]

Nuclear physicist Hank May wrote to me about this state of affairs. For many years, May has attempted to disabuse astrophysicists of the notion that magnetic fields can be open ended. He complained about the striking (but hardly ever mentioned) divergence between electrical engineers and astrophysicists in this regard. Engineers point to the necessary conclusion that Maxwell’s work states that lines used to describe magnetic fields can never end. Like electric currents, they must loop around and be closed paths.

May notes that since the 1950s most astrophysicists have asserted that the interplanetary magnetic field really is open – with one end anchored in the

Sun and the other flapping in the solar wind. If pressed, a few astrophysicists will say that the ‘open’ end actually extends to infinity. When challenged on the absurdity of this, they fall back on the argument that, okay, maybe the lines don’t extend ***to*** infinity, but they are infinitely long. (This opens up an entirely new question about their misunderstanding of the mathematical concept of unboundedness.)

When challenged that open-ended magnetic fields are a violation of Maxwell’s equation (that states the net inward and outward magnetic fluxes are equal for any closed surface) they quibble that Maxwell is not actually violated because a magnetic field line, ***being an imaginary construct***, does not have any magnetic flux associated with it. But if there is no flux, there can be no energy transfer. They want things both ways – they claim lines are either real or they are imaginary, depending on the need of the moment to ‘save the theory.’

May said he became so exhausted arguing about the flapping end that he never brought up the ends anchored in the Sun, which are even more indefensible.

What amazed him most is that the two groups have rarely clashed in the literature. Non-astrophysicists generally suppose that what the astrophysicists mean is that the ‘open’ lines extend far away from their source, but eventually somewhere they meet up with their ends. But, based on his exhaustive arguments with one of the leading authorities and on communications with others, that is definitely ***not*** what astrophysicists generally believe. So far the two groups have avoided confrontation.

May said, “This is not just an academic detail of little consequence. It bears directly on the failure, for over half a century, to understand the very source of the interplanetary magnetic field.” He recalled one of his many experiences:

> This man was an authority, having authored dozens of articles about the solar magnetic field, but the interesting part is that I copied E.N. Parker on most of the correspondence and heard back from him from time to time. He agreed with what this fellow was telling me. As you probably know, Parker originated the idea that the ‘open’ field stretches out along Archimedean spirals, in 1958; he never used the term ‘open’ in that article, but the ‘open’ concept gradually crept into

the literature, and Parker himself wrote passionately on the subject of open solar fields which leak out of the heliosphere and wander around the galaxy. He also described open lines as passing through each and every star in the galaxy.

Magnetic Reconnection

'Magnetic reconnection' refers to any location within a magnetic field where certain of the 'lines' form a 'saddle point.' Alfvén called these 'neutral points.' At such a point, two magnetic field lines come directly toward each other and two others leave at some angle from the intersection point. It is easy to demonstrate that, at any such point, the field strength is zero-valued. Where the field strength is zero, the energy stored at that point is also zero.

Energetic ions released from the Sun were first observed in the 1940s, and the appallingly mistaken notion of magnetic field lines 'reconnecting'[95] has since been proposed to explain this phenomenon. One web page[96] gives an uncommonly clear history of this invention.

> In 1961, James Dungey proposed … magnetic reconnection, an idea that Ronald Giovanelli conceived in 1946 to explain solar flaring. When more or less oppositely pointing field lines approach each other, they can abruptly short-circuit or 'reconnect,' as shown in [figure 24]. In the new reconnected configuration, the field lines are bent tightly like the elastic strings of a catapult. When the field lines suddenly straighten, they fling out plasma (shown as dashed lines in [figure 24]) in opposite directions.

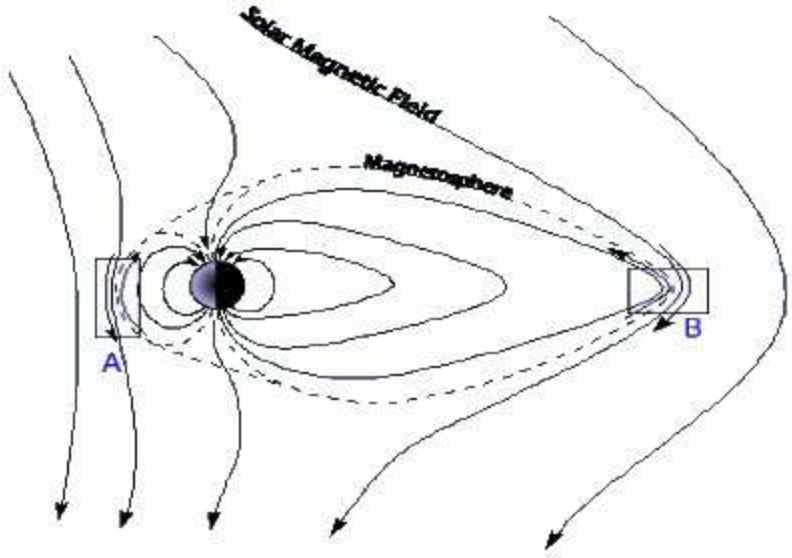


Figure 23: Areas in which solar astronomers say ‘magnetic reconnection’ can occur.

In figure 23, the magnetosphere (shown by dashed lines) is, in three dimensions, a lop-sided toroid (doughnut) shape. The solar magnetic field passes in front of it (on the left) and in back of it (on the right). More or less oppositely pointing field lines approach each other generally everywhere on the surface of the magnetosphere (shown most clearly in the two boxes marked A and B in the diagram). These are areas where astronomers say ‘magnetic reconnection‘ can occur.

We will consider those regions below, but first we must note that a magnetic field can be ‘bent tightly’ (as in the curving of the fingers in figure 25) ***only*** by the presence of a strong electric current. At any point in a magnetic field, ***B***, the degree of curling in that field is directly proportional to the strength of the electric current flowing through that point. This property of magnetic fields is called the ‘right hand rule.’ The only way to get ‘the field lines’ (your fingers) to suddenly straighten (uncurl) is to stop the electric current.

There is nothing unusual about the conditions in the rectangular boxes in figure 23. This configuration occurs regularly. For example, this happens in the volume between two parallel conductors (wires) that are both carrying

current in the same direction. This situation is sketched in figure 26a. In that figure, we see a cross section of two equal amplitude electric currents flowing away from the viewer. The right-hand rule (figure 25) tells us that each conductor will be surrounded by a clockwise-directed magnetic field, ***B***.

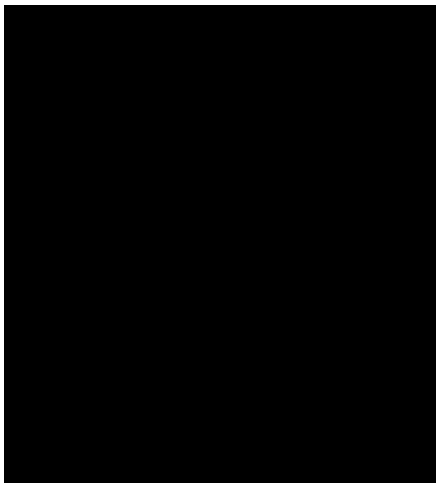


Figure 24: The ‘reconnection’ concept.

In the exact center of the diagram, inside the rectangle drawn there, we have a saddle point configuration. Each of the dashed line paths that intersect at the saddle point is called a ***separatrix***. Each defines a locus where on one side (inside the path) magnetic flux links only one conductor, and on the other side (outside the path) flux links both conductors. Just above the center of the diagram, the direction of the magnetic field is downward from the upper left. Then it becomes horizontal just above the saddle point. It curls toward the upper right and then proceeds clockwise around both wires to complete its ***closed path***.

The field’s weakest value (zero) occurs precisely at the central saddle point. At this point the current on the right is producing a vertically upward magnetic field and the current on the left is producing an equal strength downward field. These two oppositely directed equal strength fields simply cancel each other. The resulting magnetic field strength at the saddle point is zero. Therefore, this is called a neutral point. There is nothing strange or unusual about it.

In figure 23, the dashed line depicts the surface of Earth’s toroidal (doughnut shaped) magnetosphere. This surface is a magnetic separatrix. Outside that surface, magnetic flux links both the Sun and Earth. Inside that

surface, magnetic flux links only Earth. At points central to boxes A and B (and all along the dashed line), the net magnetic field strength is zero.

The surface of the magnetosphere serves to separate equal and oppositely directed magnetic fields – it is a neutral surface.

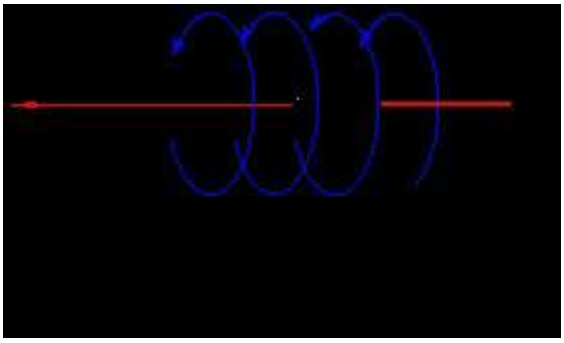


Figure 25: The Right-Hand Rule

Energy is stored in magnetic fields. The energy stored at any particular point in a magnetic field is propor-tional to the square of the strength of the magnetic field at that point. If the strength of the field at any given point is zero, then the stored energy there must also be zero. No energy is stored at a neutral point.

No energy release can occur from any location at which no energy is stored.

Thus the 'magnetic reconnection' mechanism fails as a cause of explosive ejections of matter from the Sun or as the cause of coronal heating.

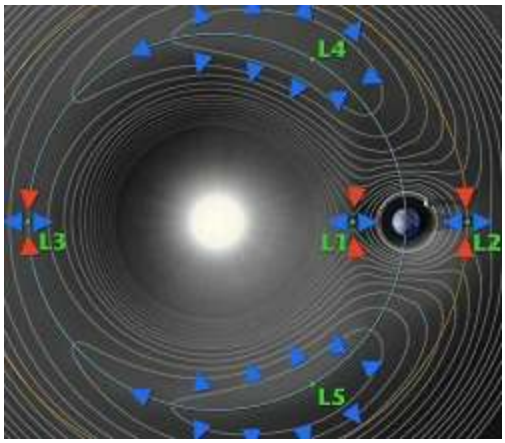
If we go far enough away from the wires in figure 26a, the magnetic field will become almost circular (cylindrical in three-dimensional space). The two conductors become indistinguishable and have the effect of one conductor. The intensity of the magnetic field drops off inversely as the ***first*** power of the radial distance from the point central to the two conductors.[97]

The reader should try to visualize the field itself without using the artifice of the lines. The field is a continuum. It is smooth – analogous to a fog of varying density, except that each point in it has a direction associated with it.[98] At each 'neutral point,' the field strength is zero – the fog disappears.

Field lines can also be used to illustrate the magnitude and direction of a ***gravitational*** field. Gravitational fields are also continuous and have a direction associated with each point within them.

Figure 26a: The magnetic field around two wires.

Consider the free-fall trajectories that a set of bombs dropped from a fleet of sta-tionary hot-air balloons would generate. These lines would be directed vertically downward (radially toward Earth's center). These paths can be considered '***gravitational field lines***.' They too do not 'open-up' or 'reconnect.' Think of all the strange phenomena we might be able to explain by proposing that these gravitational field lines sometimes can get 'short-circuited,' 'open-up,' and then 'reconnect,' thereby releasing energy (the 'Bermuda Triangle' comes to mind). That is nonsense. So is the same proposal when made concerning magnetic fields.



Credit: NASA/WMAP Science Team

Figure 26b: Contours of the Sun/Earth gravitational field showing Lagrange equilibrium (neutral) points.

On a larger scale, the gravitational field that surrounds the Earth–Sun combination is a continuum. It, like the magnetic field of figure 26a, contains

some interesting ‘singular points’ (called Lagrange points[99]). Three of these (L1, L2 and L3 in figure 26b) are also saddle points or neutral points. So far, we do not hear astrophysicists proposing that ‘reconnecting gravitational field contours throw off energy’ from these locations. L4 and L5 are unstable.

But the two situations are completely analogous. The lines in figure 26b are closed contours analogous to the closed contours on a topographical map. The arrowheads in figure 26b all point toward regions of lower mechanical potential energy. They point in the direction of the ‘gravitational force lines’ mentioned in the previous paragraph. The Sun and Earth live in adjoining ‘pits’ in this gravitational field.

Hannes Alfvén condemned[100] the ‘merging’ and ‘reconnecting’ concepts:

> The most important criticism of the ‘merging’ mechanism is due to Heikkila[101] who, with increasing strength has demonstrated that it is wrong. In spite of all this, we have witnessed at the same time an enormously voluminous formalism building up based on this obviously erroneous concept. Indeed, we have been burdened with a gigantic pseudoscience which penetrates large parts of cosmic plasma physics.
>
> I was naïve enough to believe that such a pseudoscience would die by itself in the scientific community, and I concentrated my work on more pleasant problems. To my great surprise the opposite has occurred: the ‘merging’ pseudoscience seems to be increasingly powerful. Magnetospheric physics and solar wind physics today are no doubt in a chaotic state, and a major reason for this is that part of the published papers are science and part pseudoscience, perhaps even with a majority in the latter group.

A particularly revealing statement appeared on one of the Internet sites of the prestigious Princeton Plasma Physics Laboratory.[102]

> “Magnetic reconnection (henceforth called ‘reconnection‘) refers to the ***breaking and reconnecting*** of oppositely directed magnetic ***field lines*** in a plasma. In the process, magnetic field energy is converted to plasma kinetic and thermal energy.
>
> In plasma physics, it is well known ***that magnetic field lines are***

> ***'frozen-in' to an infinitely conductive plasma***. Since charged plasma particles are confined to circular orbits around magnetic field lines, this means that infinitely conductive plasmas will not diffuse across field lines and mix. Conversely, two distinct field lines will remain separate since they cannot penetrate the intervening plasma. In most cases, ***solar and magnetospheric plasmas can be described very accurately with such a theory*** since they are both very conductive. However, straightforward application of the theory would remove the possibility of ejected solar plasma penetrating the magnetosphere since the plasmas would not be allowed to mix. Nevertheless, based on observations and known technological disruptions, we know that they must mix, ***but how***?" [Emphasis added.]

Note the continued ignorance of the fact that magnetic fields are ***not*** 'frozen into' plasmas and that plasmas are ***not*** perfect conductors. This lack of knowledge is surprising, given the fact that it has been over thirty years since Alfvén's 1970 Nobel Prize acceptance speech in which he pointed this out. This misunderstanding is what leads to the bewilderment expressed in the last sentence in the above statement.

Alfvén remarked,[103]

> From the point of view of the traditional theoretical physicist, a plasma looks immensely complicated. We may express this by saying that when, by an immense number of vectors and tensors and integral equations, theoreticians have prescribed what a plasma ***must*** do, the plasma, like a naughty child, refuses to obey. The reason is either that the plasma is so silly that it does not understand the sophisticated mathematics, or it is that the plasma is so clever that it finds other ways of behaving, ways which the theoreticians were not clever enough to anticipate.

The Princeton statement that plasmas are "described very accurately with such a theory" is blatantly untrue. Indeed, if plasmas can be described very accurately with such a theory, why have all attempts to ***use*** this theory in order to obtain a sustained and controlled nuclear fusion reaction here on Earth been so spectacularly unsuccessful for more than 50 years?

At a recent conference, a space and atmospheric scientist announced in the abstract of his talk that he would discuss "the implications of the [Hall]

effect for the possibility of '***Alfvénic reconnection***' in astrophysical systems." Dr. Anthony Peratt, who earned his doctorate under Alfvén, said in response, "I just now noticed the term Alfvénic reconnection. Read Alfvén's *Cosmic Plasma* on 'reconnection'. He says it deserves no attention. He would be spinning in his grave had he [seen] this."

It is an unconscionable insult to associate Alfvén's name with this nonsense concept that he fought so long and so hard to combat.

It is clear that the search for 'non-thermal' energy transport mechanisms has led astrophysicists to claim for magnetic fields properties they do not have. But even when propped up on this spurious crutch, they are having problems:

> We find that after a typical small magnetic loop emerges, it fragments and drifts around and then disappears in only 40 hours…. It's very hard to understand how such a short-lived effect could be driven by the magnetic dynamo layer that is over 100,000 miles beneath the surface of the Sun. This may be evidence that unknown processes are at work in or near the solar surface that continuously form these loops all over the Sun.

Note the reference to the 'magnetic dynamo.' The dynamo has become a kind of hypothetical hidden genie that is credited with being able to create all the fanciful magnetic field effects that present day solar astronomers need to invoke in order to explain enigmatic observations. The Electric Sun hypothesis requires neither hidden mechanisms nor impossible 'newly discovered' magnetic processes.

As of this writing, vast sums of research money are being poured into investigations of magnetic reconnection. In March of 2005, a worldwide conference[104] was held on this topic. The organizers said, "The recent development of astrophysical observations has revealed that the universe and astrophysical objects are much more dynamic than had been thought. They often show flares, bursts, jets, and high-energy particles, and most of them are more or less related to magnetic reconnection."

Make no mistake about it – open magnetic field lines and magnetic reconnection cannot and do not occur. They simply do not exist. Astrophysicists who do not understand magnetic fields irresponsibly propose these invalid concepts. But no one is at liberty to fabricate non-existing 'new'

properties of magnetic fields no matter how convenient these new properties might be for propping up outmoded theories. That solar astronomers feel free to promote these fictions speaks volumes about the state of astrophysics today.

Image by the author.

Plate 5. The Horse-head Nebula in Orion. The red background is an emission (glow) plasma and the ‘head’ is a foreground dust cloud.

Chapter 13

The Solar System

Astronomers tell us about the immense emptiness of space, about how vast the voids are between the planets, stars, and galaxies, and how, within this vastness, only occasional dust motes float millions of miles from each other. That is not so.

Credit: SOHO – LASCO – EIT, ESA NASA

Figure 27: A coronal mass ejection showing a twisting Birkeland current.

Almost all of space is occupied by plasma – mostly in the dark current mode. The planets and their moons each carry an electric charge. This causes them to be surrounded by a sheath as they move through the rarified plasma that surrounds the Sun. The Sun, too, carries an electric charge. The interplanetary plasma (the solar wind) makes up another much larger sheath that surrounds the Sun as it moves through the even more rarified plasma that fills our Milky Way galaxy.

In solar flares and coronal mass ejections (CMEs), charged particles are thrown outward from the Sun. These flows constitute electric currents, which in plasma take the form of Birkeland currents: They twist. See figure 27.

Each planet is an intruder in the solar plasma. As far as we can tell from our space probes, each planet is surrounded by its own cell of plasma, called its plasmasphere. A double layer (DL) separates the plasmasphere from the solar plasma. It should be noted that Venus has little if any magnetic field,

but it does have a large plasmasphere. This is an example of why the words ***magnetosphere*** and ***plasmasphere*** are not interchangeable. The same is true of Saturn's moon Titan – it, like Venus, has a large plasma tail but no discernable magnetic field.

The size and shape of each planet's plasmasphere is determined by the difference between the electrical potential (voltage) of the planet and that of the nearby, surrounding solar plasma. The resulting form of this planetary plasma sheath is usually a teardrop or windsock shape, the pointed end trailing away from the sun. Venus's plasma tail extends almost as far as Earth's orbit.

Our Moon has no such sheath, indicating that it has reached voltage equilibrium with the solar plasma in its vicinity. The Moon also has no measurable magnetic field surrounding it.[105] But it penetrates Earth's plasma tail near the time of the full Moon. Because it is then an 'intruder' it may have some disruptive effect on Earth's plasma tail.

Earth

For us, standing here on Earth's surface, what if anything do we see or sense of our planet's plasmasphere? The short answer is: just about nothing other than lightning strokes and occasional aurora displays. In fact, the surfaces of the rocky planets such as Mars and Earth are about the only places – other than an occasional moon – where plasma is not supremely important.

Atmospheric pressure at Earth's surface[106] is approximately 14.7 pounds per square inch. It decreases smoothly and exponentially with altitude. It falls to half the sea-level pressure at an altitude of 5 km (~16,000 ft.) and to one-fourth at 10 km. For every 10,000 feet increment, we multiply the pressure by 0.66. Therefore, at a height of 200,000 ft., the pressure is zero to two decimal places. So, we can say the height of the atmosphere is effectively somewhere around 38 miles, or 60 km. This is roughly five times as high as commercial jetliners normally travel.

The region from the ground to a height of 10 km is called the troposphere. It consists of neutral oxygen and nitrogen and a very few ions. Most weather systems occur within it. Atmospheric pressure at the top is approximately 4

pounds per square inch. The region from 10 to 50 km is called the stratosphere. Highflying jetliners travel in its lowest regions; hot-air balloons can get up to around 20 km; helium balloons have risen to nearly 35 km. At 35 km the atmospheric pressure has dropped to around 0.15 pounds per square inch.

The band from 50 km up to 80 km is known as the mesosphere. Little is known about this layer because it is too high for balloons and too low for satellites. It is essentially a transition layer between the stratosphere where no ionization takes place and the ionosphere where high levels of ionization occur. At 80 km the atmospheric pressure is down to a meaninglessly low number (except for bodies traveling at extremely high velocities such as satellites). It is within this region that the electric phenomena known as Sprites are found.

The Sun produces broadband electromagnetic radiation ranging from low-frequency radio through infrared (IR), visible, ultraviolet (UV), and x-rays. The photons of UV and higher frequencies have enough energy to ionize neutral molecules of Earth's atmospheric gases.

At the highest altitudes there are not many gas molecules around to hit, so ionization levels are low. As altitude decreases, the probability of collision increases and thus so does the amount of ionization. But with decreasing altitude comes an increase in atmospheric density, so there is also an increasing opportunity for an ion to recombine with a passing electron and return to the neutral state.

As we travel farther down into the denser levels of the atmosphere, there is still more opportunity for ionization and recombination. Various gases are ionized most easily at different altitudes. Therefore, the degree of ionization varies non-uniformly with altitude. The result is a layered onionskin of altitude levels that have varying degrees of ionization density. These are typically labeled as follows:

- D (50 to 90 km)
- E (90 to approximately 120 km)
- Sporadic E
- F1 (approx 120 km to 200 km)
- F2 (above 200 km)

As was discussed earlier, the ionization density of each of these layers

determines its ‘plasma frequency.’ This frequency controls which radio signals will be reflected back toward Earth’s surface (propagated from one point on the surface to another) and which ones will be allowed to pass into space. Transmissions of higher than the plasma frequency of any layer will penetrate up through it.[107]

Obviously, in order to transmit signals back and forth to deep space probes, NASA must use radio frequencies higher than the highest plasma frequency of any of these ionospheric layers.

Although essentially no ionization regularly occurs below the bottom of the ionosphere,[108] photons are able to penetrate down to the lower level of the stratosphere with enough energy to occasionally break normal oxygen molecules into two O_1 atoms, each of which can then combine with another oxygen molecule to form O_3, which is ozone.[109] The ozone layer typically ranges between 20 and 30 km in altitude.

Thus we can say that the Plasma Universe begins roughly 80 km (260,000 ft.) above Earth’s surface. Because humans have always lived far below that level, we have ignored the existence of electric plasma until recently.

Several thousand miles above the top of the ionosphere are two toroidal (doughnut shaped) formations of charged particles that surround Earth, trapped there by Earth’s magnetic field.

Charged particles traveling at right angles to a uniform magnetic field are constrained to travel in circles. If they travel in the direction of the field, their motion will not be affected by it. If they travel at an angle to the field, the path will therefore be a spiral – a helix. These currents are sometimes referred to as ‘field aligned currents.’

The critical word in the previ-ous paragraph is ‘uniform.’ If the field strength through which the charged particle is traveling gets stronger, the circle will get smaller – the spiral will tighten. Any charges spiraling within a volume wherein a magnetic field is suffi-ciently stronger at both ends than it is in its central region will eventu-ally be reflected back in the direc-tion from which they came. Such a situation is shown in figure 28. Because of variations in the mag-netic field strength, some charges are gradually but continually enter-ing and leaking out of such regions.

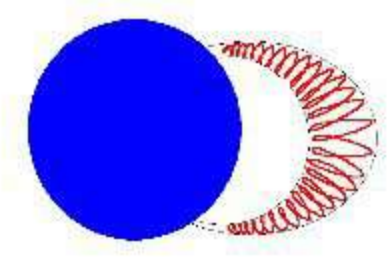


Figure 28: Ions trapped by Earth's Magnetic Field. Such ions oscillate back and forth, spiraling from north to south and vice versa.

Most curiously, there is an azimuthal (East to West) equatorial flow of these particles: positive ions tend to move horizontally toward the west and electrons toward the East. This produces a net east-to-west electric current within these toroidal regions that encircle Earth. This current is called the Ring Current. It is not yet clear why this current exists.

You may read explanations of this process of ion entrapment that invoke the idea that charged particles must spiral around magnetic field *lines*, or that they are trapped between magnetic field *lines* or are attached to them. These explanations may be convenient for visualizing what is happening, but, as we have pointed out, the magnetic field is a continuum – it does not really contain any discrete 'lines' to which charges are attached.

For example, the following quote, taken from a NASA web page[110] is particularly misleading.

> The laws by which ions and electrons are attached to magnetic field lines break down at neutral points or line, where the field goes down to zero. If the plasma flows through the neutral line, a process known as magnetic reconnection (or magnetic merging) occurs instead. Interplanetary field lines enter from one side, terrestrial ones from the other, each splits into two parts and the halves then reattach in such a way that a northern '***open***' line forms, half interplanetary, half terrestrial, and similarly on the southern side after reconnection.[111]

But there are no laws of electrical science that say ions and electrons are 'attached to magnetic field lines' – and astronomers are not free to cite them. And as we have pointed out repeatedly, '***open***' magnetic field lines and 'magnetic reconnection' are nonexistent mechanisms.

As a result of the actual confinement mechanism, charges are herded into

two separate toroidal belts around Earth. These are named the Van Allen belts. David Stern, a researcher at NASA Goddard, correctly answered a question[112] about the Van Allen belts as follows:

> The radiation belts are regions of high-energy particles, mainly protons and electrons, held captive by the magnetic influence of the Earth. They have two main sources. A small but very intense inner belt … is trapped within 4000 miles or so of Earth's surface. It consists mainly of high-energy protons (10-50 MeV) and is a by-product of the cosmic radiation, a thin drizzle of very fast protons and nuclei, which apparently fills our galaxy.
>
> The outer belt contains mainly electrons with energies up to 10 MeV. It is produced by injection and energizing events following geomagnetic storms, which makes it much more dynamic than the inner belt. (It is also subject to day-night variations). It has an equatorial distance of about 3 - 9 R_e [Earth radii], with the maximum for electrons above 1 MeV occurring at about X = 4 R_e. Horns of the outer belt dip sharply in towards the polar caps.

Recently a new belt has been found within the inner belt. It contains heavy nuclei (mainly oxygen, but also nitrogen, helium, and a little carbon) with energies below 50 MeV/nuc. The source of these particles is the so-called 'anomalous cosmic rays' of interstellar origin.[113]

All four of the giant gas planets of our solar system, Jupiter, Saturn, Uranus, and Neptune, possess strong magnetic fields and belts of ionized particles. Jupiter's magnetic field is 20,000 times as strong as Earth's, and its ionization belt much more intense. Venus has no discernable magnetic field, and Mars has weak localized periodic magnetic fields distributed across its surface. The magnetic fields of both Saturn and Uranus are strangely pitched over (at almost right angles to their rotational axes).

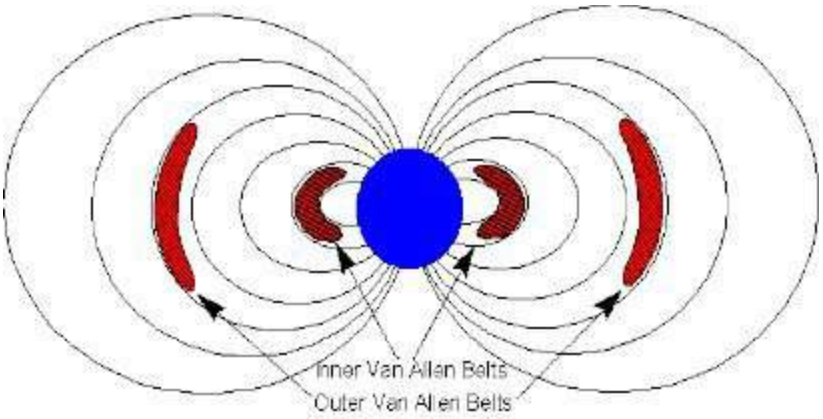


Figure 29: The 'radiation belts' that surround Earth.

The Sun also has a torus-shaped belt.[114] This formation was discovered several years ago by the SOHO probe. The ions in the lower (brightest parts of the) corona form this toroidal belt. A motion-picture-like 3D display of this formation is available on the CD entitled *SOHO Exploring the Sun.*[115]

The Van Allen belts are connected to Earth's ionosphere. Researchers at Stanford University put out the following press release:[116]

> Within roughly a second of a single lightning flash in Texas, electrons can precipitate out of Earth's radiation belts onto the upper atmosphere above an area spanning Oklahoma to South Dakota, researchers at Stanford have found. Theirs is the first evidence that lightning can have such a far-ranging effect – temporarily changing the composition of the radiation belts and the ionosphere below it within an area of several hundred thousand square miles.

Umran Inan, a professor of electrical engineering in Stanford's STARLab (Space, Telecommunications and Radioscience Laboratory) stated that, "The findings, reported in the December 1, 2002, issue of Geophysical Research Letters, suggest lightning could be an important contributor to the loss of electrons from Earth's radiation belt, and thus helps us better understand Earth's near-space environment."

Sprites and ELVES[117] are extremely high altitude phenomena associated with lightning discharges. Sprites and ELVES are triggered by positive cloud-to-ground lightning flashes. ELVES are generally horizontal ring formations that occur at approximately 100 km altitude. Sprites are vertical plasma clouds (almost squid shaped) hanging below the ELVES. Sprites

range down to 50 km or so above Earth's surface.

Given what we now know, it seems likely that electric charge is transferred from the solar plasma to the Van Allen belts and thence onto the upper atmosphere. The ELVES and Sprites continue the path downward, and the familiar lightning stroke to Earth completes the path. All of this is in addition to the auroral current path discovered by Birkeland. Therefore, ionized paths, some almost permanently in place and others that come and go, provide a direct link from Earth's surface to the Electric Sky.

Electric Scarring

The Grand Canyon of Arizona may be an example of electric discharge machining (EDM). Geologists have proposed a variety of processes for its formation but none accounts for all the facts. If the Canyon were carved by the Colorado River, as has long been claimed, where is the river delta? Where is the rock that once filled this 10-mile-wide, 230-mile-long and one-mile-deep canyon? It has all disappeared.

In addition, the Colorado River would have had to flow uphill in order to cut the Canyon into the Kaibab plateau. Geologists assume that first the river was there and then the land rose. But rising land would have diverted the river. Indeed geologists have found that ancient rivers in the region flowed in the opposite direction, toward the northeast, suggesting that the plateau predated the river. And lake sediments across the Canyon's mouth, through which the Colorado River cut, constrain the time for cutting the Canyon to an implausibly short duration. A geologist once remarked that the Colorado River could have cut the Grand Canyon only if the River came from the sky. He may have been more accurate than he imagined.

These puzzles would be solved if an electric discharge from space, perhaps from a large intruder, cut the Canyon and lifted the debris into space. The new gash through the plateau would then have captured the Colorado River. Aerial photographs of the Grand Canyon show a strong similarity to Lichtenberg patterns – scars such as those made on golf course greens when the flag in the hole has been hit by lightning.

Arizona's 'Barringer Meteor Crater' may be another instance of an electrical phenomenon. No substantial evidence of the 'meteor' that formed the crater has been found. Some small meteoric matter has been unearthed in

the region, but not nearly as much as would have been necessary to create the crater. There is no detritus from the crater for miles around it, suggesting that the crater's material was lifted away.

Many other so-called meteor craters have spires of material in their centers. These central columns are sometimes stratified identically to the strata of the material beyond the crater walls, refuting the claim that these central columns are all caused by a rebound of debris. They consist of undisturbed material. Such craters are easily formed by circular arc machining but not by impact.

Venus

Recently NASA astronomers have discovered what they call 'stringy things' in the long plasma tail of Venus. Such twisted 'stringy' shapes are exactly the filamentary paths Birkeland currents take in plasmas. Apparently Venus is discharging an electric current.

Consider that observation together with the observation made by the Magellan probe of the surface of the planet: The only way to glimpse what lies beneath Venus's opaque clouds is by radar. Magellan's images showed the planet was covered with volcanic features, such as vast molten lava plains, fields of small lava domes, and large shield volcanoes. But the images were puzzling as well. It appeared that parts of the highlands were abnormally bright, reflecting radar beams much better than lower elevations.

Wal Thornhill commented on this observation as follows:

> Diffuse electric discharge, known on Earth as 'St. Elmo's fire,' occurs preferentially at the higher altitudes of the mountains on Venus. In that thick atmosphere it forms a highly conductive dense plasma, which is a superb reflector of radar signals.
>
> The density of the atmosphere at the surface of Venus is about 1/10 that of water [extremely dense for an atmosphere]. St. Elmo's fire is a highly ionized state involving actual electrical discharge. Put the two together and you have dense plasma – which conducts like a metal and therefore reflects radar like a metal surface.

These two observations (the filaments in Venus's plasma tail and radar luminance of its mountains) strongly suggest the presence of an ongoing

plasma discharge on the surface of Venus.

The plasma tails of all the planets today are in the dark current mode of operation – they emit no light. But were they always thus? The ancients reported that Venus once was seen to have a ‘fiery tail’ and ‘twisted hair.’ Could it have been that her long plasma tail was then in the normal glow or even the arc mode of operation? What a sight that would have been.

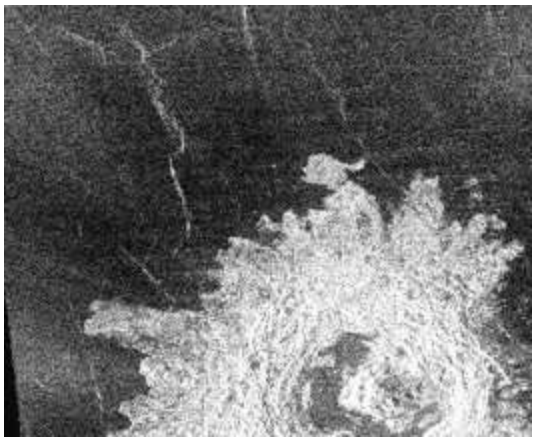
Consider for a moment what the shape of Venus’s plasma tail would look like if it were visible. The diameter of the plasma sheath around Venus is possibly five or six times the planet’s diameter – say about 50,000 miles. But the distance from Venus to Earth during her closest approaches is in the order of 26 million miles. So the Venusian tail is several hundred times as long as it is broad at its head. It is a long, thin, snakelike shape. If, at some time in the past, this plasma tail were in the normal glow mode, it would have been visible from Earth. How would the ancients have described it? Would it have looked liked a dragon with a ball in its mouth? Such images are associated with Venus in ancient cultures worldwide.

When a double-layer sheath surrounds a planet, it is protected from direct electrostatic interaction with any outside body. Two planets, each surrounded by an intact plasma sheath, can have no electrical effect on each other. That is why electrostatic forces between planets can be ignored. However, if a body having a different electrical potential (voltage) penetrates the double layer boundary and moves into the plasmasphere surrounding a planet, charges will flow to try to cancel the voltage difference. Electrical discharges will occur. Thus, if any other body, such as a large meteor, asteroid, or comet should come close enough to Earth to penetrate our plasma sheath, violent electric discharges would occur between the two bodies. It would, of course, be unfortunate to be standing on Earth’s surface at the point of origin (or reception) of such a mega-lightning discharge. But the massive discharge itself might either deflect the intruding body or break it up and thus protect Earth from a collision.

Such large-amplitude arcs would undoubtedly cause scarring on the surface of both bodies. A very small intruder would be broken up by the discharge. It is likely that this is what happened to comet Shoemaker-Levy 9 as it entered Jupiter’s giant plasmasphere a few years ago.

A similar kind of electric discharge can occur if one planet’s magneto-tail intersects that of a second planet. Charge from the higher-voltage body flows

to the other body. We have seen that the plasma sheath of Venus is extremely long, almost touching Earth when the two planets are at their closest approach. Jupiter's plasma sheath has the same relationship with Saturn. This mechanism could stabilize planetary orbits.



Credit: NASA Magellan, JPL.

Figure 30. Venus's crater Buck.

Many people are not aware that the rotations of Venus and Earth are synchronized in a subtle way. Venus is the only planet in our solar system that rotates 'backward' on its axis (clockwise when looking down at its north pole). Each time Venus makes its closest approach to Earth (this position is called inferior conjunction), the same face of Venus looks toward Earth.

These inferior conjunctions occur repetitively at precisely five specific points in Venus's orbit. This is what engineers call a 'phase lock' mechanism[118] between Venus's rotation and Earth's. Could it be that the subtle electrical interaction between these two planets, enabled by Venus's plasma tail brushing past Earth's plasmasphere, has caused this synchronization to occur?

Figure 30 shows a close-up of Venus's crater Buck.[119] It is an example of the quenching of the spiraling arc that formed the crater before it completed its full rotation. The standard explanation for these horseshoe-shaped craters is that one side of the crater wall has collapsed. Although such a collapse could occur in an EDM-formed crater, the 'non-missing matter' in many of these horseshoe craters is likely undisturbed surface material, not rubble.

Sinuous rilles are one of the typical characteristics of electric arc

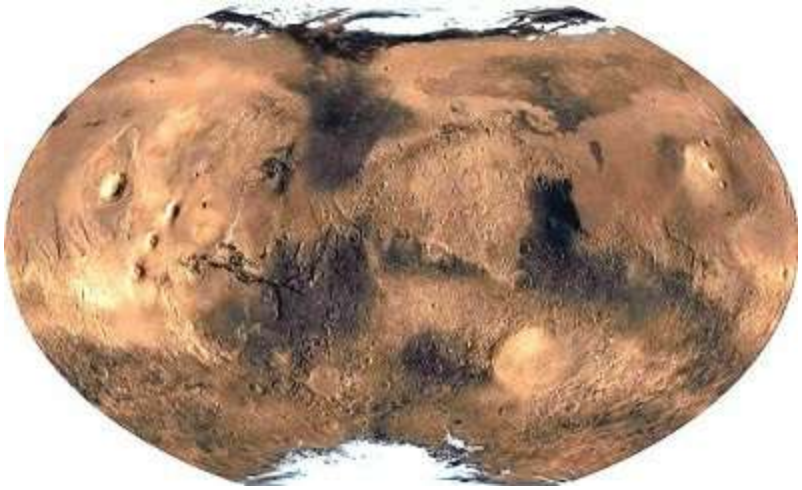
machining. Electrical and magnetic forces tend to constrain them into radial and concentric patterns around an intense discharge. Many craters, as also seen in this image, are surrounded by such a pattern of rilles.

If all the craters on Mars, Venus, and our Moon were really formed by impacts, then probability would dictate that many of them would be elliptical. Meteors rarely come straight down. On the other hand, electric fields always impinge on conducting spheres at right angles to their surfaces (i.e., vertically). The consistently exact circularity of craters throughout the solar system points to their electrical origin.

Mars

Credit: Viking Project – NASA

Figure 31 Mars's Valles Marineris



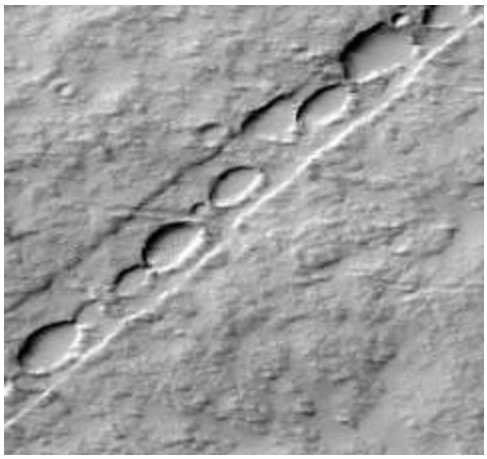
Credit: National Geographic Society, MOLA Science Team, MGS, JPL, NASA

Figure 32: A full image of the entire surface of Mars.

Thornhill and other like-minded investigators also theorize that electric discharge machining (EDM) produced a monstrous scar across the face of Mars (the canyon called Valles Marin-eris). The rocks and rubble that are found strewn every-where across the landscape of Mars are probably the detritus from this huge excavation. So may be the 'Martian meteorites' that have been found here on Earth. The size of that scar is enormous – 4000 km in length and from 50 to 100 km wide. It is eight km deep. Arizona's Grand Canyon is only 1.8 km in depth. The Grand Canyon would be lost in one small section of this deep scar, and Mars is a much smaller planet than Earth.

There are many other examples of electrical scarring on Mars. Electrical scars have characteristics that enable us to distinguish clearly between them and water erosion and impact cratering.

A full surface image of Mars is presented in figure 32. Notice that the southern hemisphere is covered with craters. The northern hemisphere is, for the most part, smooth and has many fewer craters. Many bodies in the solar system display this hemispheric pattern. What in the history of the Red Planet caused this non-uniform scarring of its surface?



Credit: NASA

Figure 33: Sinuous riles on Mars

Figure 33 shows an image of Martian ‘sinuous rilles.‘ They are made up of chains of craterlets. This too is character-istic of electric discharge machining and distinguishes it from fluid flow. A discharge channel moving across a surface can briefly stick to one spot, carve a crater, and then jump to a nearby spot. This produces a line of elongated or over-lapping craters. The continuous blast effect erodes a wider uniform channel along the path. All these effects are seen in figure 33.

Credit: NASA

Figure 34: Terraced crater on Mars.

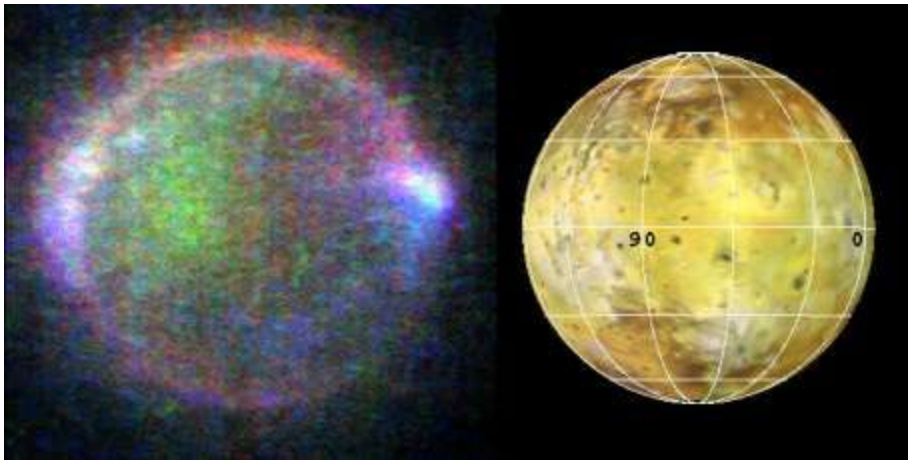
Notice, near the center of the image, the faint rille crossing the large one. This small rille was obviously made later than the large rille. Most important is the fact that this small rille goes up hill and down hill, cutting right across

the earlier structure. This eliminates any kind of gravity-driven fluid flow as a possible source for these structures. Water or other liquids would not do that.

Terraced crater walls and small secondary craters sitting on the edge of larger craters are also characteristic of electric arc machining. Notice the flat floors and almost perfect circularity of the craters. If the twisting arc that creates an electrically formed crater stops on the rim and does not extin-guish, it will form a secondary crater. This effect is clearly demon-strated in a laboratory experiment shown on Thornhill's CD "The Electric Universe."

Jupiter's Moon Io

All four of the large moons of Jupiter orbit the planet completely within its plasmasphere. They are therefore electrically connected to the planet. Wal Thornhill notes that Io, the innermost of those four moons, is presently experiencing electric discharges from Jupiter and is being 'electrically machined' as a result. He points out that Io is a laboratory (on a planetary scale) of ongoing electric plasma discharges sitting right in front of us, if we are only willing to see it for what it is. In the photo of Io shown in figure 35, this small moon is pretty much aglow. Note the heaviest glows on Io are on the sides directly toward and directly away from Jupiter.



Credit: Galileo Project, University Of Arizona (PIRL), JPL, NASA

Figure 35: Infrared and visible light images of Jupiter's moon Io. Jupiter itself is to the right.

The famous 'volcanoes' on Io cannot be true volcanoes as we know them

because they have moved a distance of many miles since their discovery.[120] Earthly volcanoes are stationary phenomena – they do not move rapidly from place to place. But electric arc discharges have a tendency to wander around. Also the material ejected from the site of these phenomena is not disbursed over a widespread circular ***area,*** as true volcanic ejecta would be. It all lands in a thin circular ***ring*** - just as the output of a plasma gun does. These are clearly electric arc discharges, not volcanoes.

The original caption released with the image in figure 35 reads:

> This eerie view of Jupiter's moon Io in eclipse (left) was acquired by NASA's Galileo spacecraft while the moon was in Jupiter's shadow. Gases above the satellite's surface produced a ghostly glow that could be seen at visible wavelengths (red, green, and violet). The vivid colors, caused by collisions between Io's atmospheric gases and energetic charged particles trapped in Jupiter's magnetic field, had not previously been observed. The green and red emissions are probably produced by mechanisms similar to those in Earth's polar regions that produce the aurora, or northern and southern lights. Bright blue glows mark the sites of dense plumes of volcanic vapor, and may be places where Io is electrically connected to Jupiter. North is to the top of the picture, and Jupiter is toward the right. The resolution is 13.5 kilometers (8 miles) per picture element. The images were taken on May 31, 1998 at a range of 1.3 million kilometers (800,000 miles) by Galileo's onboard solid state imaging camera system[121] during the spacecraft's 15th orbit of Jupiter.

But, auroras are plasmas in the normal glow mode of operation.

A few years ago NASA directed the Galileo space probe to pass fairly close to one of the 'volcanoes' on Io, which led to an unexpected result:[122]

> On October 10 Galileo passed within 611 kilometers of Io, using its solid-state imager to reveal features as small as 9 meters across near the volcano Pillan. But radiation took its toll, zapping a critical bit in Galileo's computer memory and blurring many images.

Flying a computer through a high intensity electric field is much more likely to 'zap' its electronics than simply passing it no nearer than 380 miles distant from some smoke and molten rock. Computers located 380 miles

away from Mt. St. Helens were not disturbed by its eruption.

Other Moons and Other Planets

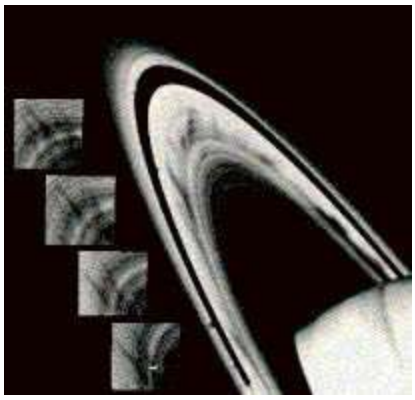
Credit: NASA, JPL

Figure 36: Neptune's moon Triton

There are over 100 moons in the solar system, and all of them display similar features of electrical scarring. For example, only the side of Triton that faces Neptune is heavily pockmarked with scarring**.**

Evidence suggests that the usual 'accretion disk'[123] explanation for the formation of these moons and planets is woefully lacking. For example, Triton travels 'backward' in its orbit around Neptune. In other words, if we look down on the north poles of both Neptune and Triton, the planet rotates in the usual counter-clockwise direction, but its moon travels clockwise in its orbit. Clearly, if both these bodies were formed from the same 'accretion disk,' their angular momentums should not be in opposite directions. At least five of the smallest moons of Jupiter also exhibit this same anomalous behavior.

Spokes in Saturn's Rings



Credit: NASA, JPL PICNO 0681S2-023

Figure 37: Spokes in Saturn's rings.

Another interesting electrical planetary phenomenon is the existence of radial 'spokes' in Saturn's ring system.[124] Their radial nature screams ***electric field*** at us. Even one of the official explanations is that "they are thought to be microscopic grains that have ***become charged*** and are levitating away from the ring plane." More likely they indicate the paths of electrical discharges in Saturn's extensive plasmasphere, analogous to Sprites in Earth's atmosphere.

These images were obtained over twenty-five years ago. Recent images of this same area of the rings have failed to record these spokes. Why this is so is not clear. Are they electrical effects, the cause of which has weakened over time? Or did we just miss seeing them this time because of the angle at which recent images were taken?

Comets

Image by the author

Figure 38: Comet Hale-Bopp showing its blue plasma tail and the dust tail.
Throughout history the appear-ance of a brilliant comet whose tail sweeps across the firmament of the night sky has inspired awe and fear. People feared that comets were the harbingers of all sorts of plagues, pestilence and of the fall of king-doms and civilizations.

About fifty years ago, astro-nomer Fred Whipple, who discov-ered six comets, suggested that these magnificent visitors from outer space were 'icy conglomerates,' later dubbed 'dirty snow-balls.' His dirty snowball theory caught the public imagination and revolutionized comet science.

Today, in the face of contradictory evidence, astronomers assume as a fact that comets consist of aggregates of ices mixed with rock and dust. As these aggregates approach the Sun, their surfaces heat up and the ices sublimate – go directly from solid to gas (plasma is not mentioned, although that is what is observed). 'Gas and dust' is supposedly swept back by solar radiation and the solar wind into those spectacular luminous tails.

We should be more restrained in accepting the 'dusty snowball' description. Evidence from probes that have visited comets argue against their being dusty snowballs. They appear to be solid bodies like asteroids and minor planets in every way except for their highly elliptical orbits. Their highly eccentric orbits cause them to pass through regions of significantly different voltage within the Sun's plasmasphere. Recall that there is a weak electric field emanating outward from the Sun. The solar plasma near the Sun is at a higher electrical potential (voltage) than is the plasma out in the far reaches of the solar system.

Because comets spend much more time in the outer (lower-voltage) reaches of their orbits than they do in the near-Sun (higher-voltage) region, they reach voltage equilibrium with the low voltage of the Sun's outer plasma. As a comet approaches the inner range of its orbit, the voltage difference between it and the solar plasma through which it is traveling rapidly increases. As current flows to the comet in response to this voltage difference, the well-known cometary effects appear – a tail and coma plasma sheath in glow mode surrounding the comet nucleus and jets (plasma arc discharges sometimes pointed in the direction of the Sun) that produce the craters observed on comet surfaces.

On July 7, 2000, the Hubble Space Telescope[125] observed comet Linear

(C/1999 S4) in the process of cracking off parts of itself as it approached closer to the Sun. The press release that accompanied the image of the breakup announced: “The eruption, the comet’s equivalent of a volcanic explosion (though temperatures are far below freezing, at about minus 100 degrees Fahrenheit in the icy regions of the nucleus or core), spewed a great deal of dust into space. … Though comet nuclei have been known to fragment, Hubble’s sharp vision is revealing finer details of how they break apart.” The press release noted that this unexpected glimpse at a transitory event might indicate that these types of Mt. Saint Helens outbursts occur frequently on the comet because it would be unlikely that Hubble just happened to catch one isolated event. Similar daughter fragments appeared when the Hubble telescope observed comet Hyakutake (C/1996 B2) in 1996.

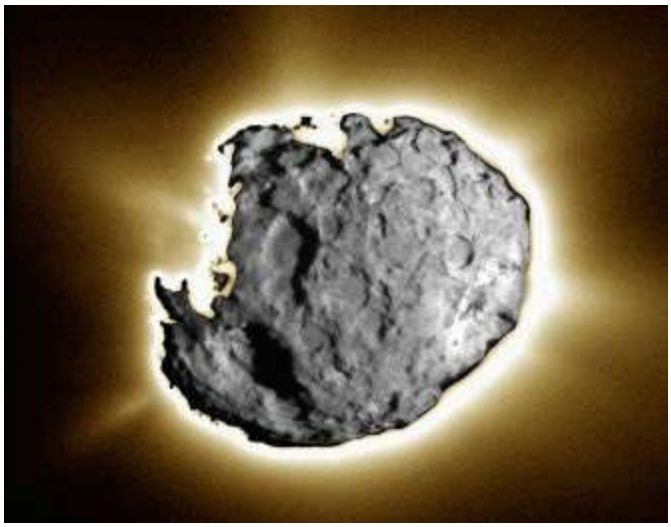
Using the words ‘volcanic explosion’ and calling these ‘Mt. Saint Helens outbursts’ is uncalled for. If the temperature of the cometary nucleus is indeed ‘far below freezing,’ then an entirely different (non-thermal) mechanism is being observed. How could a body composed of insulating material (ice, rock, dirt, snow) which is at thermal equilibrium (~ -100ºF) be exposed to radiant heat (which it would absorb on its surface) and conduct that heat to deep ‘chambers’ that would act like volcanoes? Any proposed interior mechanism will necessarily be a combination of unobservable and untestable ‘what if’ assumptions. Any proposed surface-only mechanism, such as the electrical one described above, would be more promising. Occam’s Razor would prefer its fewer assumptions, and the principle of falsifiability would prefer its observability and testability.

On March 27, 1996, The European Space Agency’s ROSAT satellite observed x-rays being emitted from Comet Hyakutake. Astronomers were again ‘surprised.’ A non-electrical ‘dusty snow-ball’ would not do that. But x-rays are expected from a high-voltage double layer such as would enclose a comet’s plasma sheath.

On July 4, 2005, NASA’s ‘Deep Impact’ mission intercepted comet Tempel 1 and fired a copper projectile at the nucleus. Many months prior to the impact, Wal Thornhill predicted what would happen:

> Given the erroneous standard model of comets it is an interesting exercise to imagine what surprises are in store for astronomers if the plan is successful. The electrical model suggests the likelihood of an

electrical discharge between the comet nucleus and the copper projectile, particularly if the comet is actively flaring at the time. The projectile will approach too quickly for a slow electrical discharge to occur. So the energetic effects of the encounter should exceed that of a simple physical impact, in the same way that was seen with comet Shoemaker-Levy 9 at Jupiter. Changes to the appearance of the jets may be seen before impact. The signature of an electrical discharge would be a high-energy burst of electrical noise across a wide spectrum, a 'flash' from infrared to ultraviolet and the enhanced emission of x-rays from the vicinity of the projectile. The energy of a mechanical impact is not sufficient to generate x-rays.



Credit: NASA/JPL Stardust probe Jan 2004.

Figure 39: Comet Wild 2. The rocky nucleus of the comet is shown superimposed on its plasma discharge.

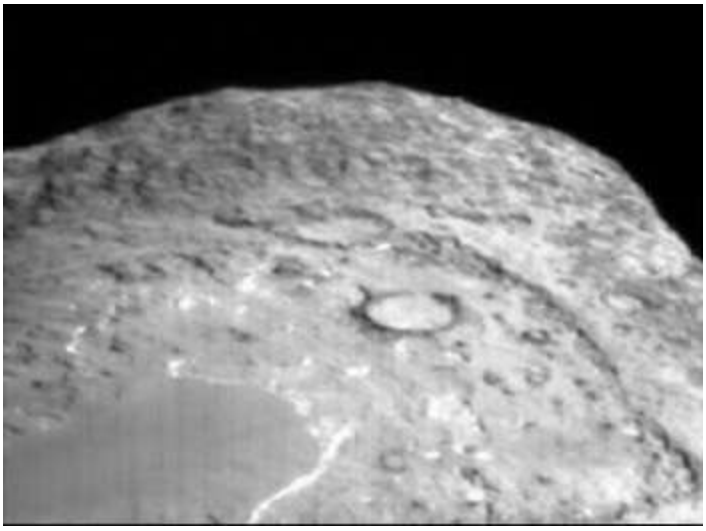
What did happen?

Exactly what Thornhill predicted.

An article in *Wirednews.com* reported Thornhill's success:

> The prediction said there would be two impact flashes: a small flash as the projectile penetrated the comet's electrified atmosphere, followed by a huge impact flash that would be 'unexpectedly energetic.'
>
> And that's exactly what appeared to happen on July 4, 2005 in an impact that astonished NASA investigators. "What you see is something really surprising," said NASA mission co-investigator

> Peter Schultz. “First, there is a small flash, then there’s a delay, then there’s a big flash and the whole thing breaks loose.”



Credit: NASA

Figure 40: Comet Tempel 1 just prior to impact.

Whatever the outcome, the self-styled ‘alternate paradigm theorists’ [Thornhill and his colleagues] are energized by the evidence from Deep Impact, as well as the shifting theories and unexplained data from previous comet observations. They point to photographs of comets by various probes that have revealed distinctly ice-free rock-like objects, and images of strange bright patches they say are proof of electrical discharges in action.

> Why are comet nuclei coal-black as if they have been burnt? Why is there a superabundance of extremely fine dust? And if comet nuclei are merely melting in the sun’s heat, why are they sharply cratered and rocky [as shown in figure 40]? They should be smooth like a melting scoop of ice cream.

The reaction of mainstream astrophysics – even after Thornhill’s prediction had been so singularly correct – was an abrupt, off-hand rejection:

> “It’s complete cobblers,” said Dr. David Hughes, comet expert and professor of astrophysics at Britain’s University of Sheffield. “Absolute balderdash. Electricity on the surface of a comet? Forget about it. It’s not a contender.”

Such a comment reveals the ignorance of the commentator. A correct prediction merits something more thoughtful and serious, especially in light

of NASA scientist Peter Schultz's comment: "What you see is something ***really surprising***." Not to Thornhill.

The Heliopause

We have repeatedly mentioned that the entire solar system resides within the Sun's heliosphere. Usually the boundary between two different plasma regions is a double layer (DL). However, in certain cases, such as in the Sun's photosphere, it can consist of a triple layer of electric charge. A precise description of the structure of the heliopause boundary of the Sun's plasma is still unknown. The Voyager probes are only now arriving and measurements are scanty. Its presence and electrical structure is predicted by the electric plasma properties of our Sun's environment.

The Pioneer probes launched more than 30 years ago, are now also approaching the heliopause.[126] Data from both probes puzzle the adherents of accepted (non-electrical) theory. The craft appear to be in the grip of a mysterious force that is holding them back as they try to sweep out of the solar system. Some researchers suppose that unseen dark matter is affecting the Pioneers' passage. Others wonder if flaws in our understanding of the laws of gravity might explain the crafts' wayward behavior.

Given their present antipathy toward any electric plasma ideas, it is questionable whether NASA astronomers will make electrical measurements to determine the existence of a double layer at the heliopause. We must infer what we can from the few reports that are released. It may well be that the Pioneer vehicles are not equipped to make such measurements.

A 2003 newspaper publication[127] gives the conventional view:

> Voyager I, launched in 1977, has become the first human emissary to approach the boundary region where the Sun's domain ends and the vastness of interstellar space begins. The first signs came in August, when the spacecraft's onboard instruments detected evidence that it had entered a new environment fraught with ***bizarre cosmic rays*** and other characteristics not seen in its previous 26 years of space exploration, scientists said Wednesday. But, they disagreed on whether the 1,600-pound spacecraft has felt the effects of 'termination shock,' a long-awaited milestone zone that the craft must cross as it

leaves the solar system. One team of researchers concludes in today's issue of the journal Nature that it definitely has, while a second says not quite yet. Either way, "we will likely be surfing this termination shock over the next three or four years," said Edward Stone of the California Institute of Technology, lead Voyager project scientist. He called the observations "unusual and ***surprising***. It means there is something new to be learned as we begin exploring this final frontier of the solar system," he said.

Termination shock is produced when the supersonic wind that flows continuously from the sun clashes with the distinctly different medium that fills the vastness of interstellar space beyond, said scientists who have awaited their first opportunity to study this frontier.

The solar wind – a thin flow of electrically charged (ionized) gas – expands continuously outward at velocities of about 1 million mph or more. It hollows out a sort of bubble in which the sun and its planets plow through the interstellar medium. When the solar wind runs into the thin cloud of ionized gas and dust that fills the space between the sun and other stars, it slows abruptly. As the supersonic flow goes sub-sonic, it creates a shock zone similar to the one that produces sonic booms when high-speed aircraft break the sound barrier.

"To ***our total amazement***," Krimigis said, "the data showed the speed had dropped by a factor of seven, from 700,000 mph to much less than 100,000 mph."

"A trailing sister ship, Voyager 2, registered no similar effects. [It has now – 9/2004] That indicated the measurements were most likely related to the environment around Voyager 1 and not to a fluctuation in the sun's activity," Krimigis said. Launched in the same year more than a quarter-century ago, Voyager 2 is traveling a different path and is almost 2 billion miles behind in the race toward the outskirts of the solar system. [Emphasis added.]

Clearly, present-day astronomers are still completely immersed in their non-electrical, fluid-flow nomenclature of 'surfing,' 'bow-shocks,' and 'bubbles.' No wonder observation of increased cosmic rays seems 'bizarre,' and again we see the use of phrases such as "to our total amazement."

There is now overwhelming evidence, from space probes and from Earth-

bound observations, as well as geological evidence of planetary scarring, that electricity has played – and continues to play – an important part in the functioning of our solar system.

Books and Links:
The Big Bang Never Happened, by E. Lerner, ISBN 0-679-74049-X
IEEE Transactions on Plasma Science, Dec. 1986; Anthony L. Peratt, ed.
Physics of the Plasma Universe, by Anthony L. Peratt, 1992, Springer-Verlag, ISBN 0-387-97575-6.

Image by the author.

Plate 6: The Pelican nebula in Cygnus, IC 5070. Notice the dark streak crossing the light ridge in the upper center. This is known as the Elephant's Trunk. The bright edge above and below the 'trunk' is an ionization front between plasma and neutral gas.

Chapter 14

Stars
(Electric Cosmology)

Up above the world so high,
Like a diamond in the sky.
Twinkle, twinkle little star.
How I wonder what you are!

Children gaze wide-eyed at a brilliant star and sing those lines. Is it insensitive of us to break that spell of wonderment and actually answer the question? The stars are balls of plasma. Their light comes from the phenomenon called electrical arc discharge.

The dazzling surface of our Sun is an electrical phenomenon, and our Sun is a fairly typical star. Therefore, all stars should exhibit properties that are consistent with the Electric Sun (ES) model. Do they? Let us see how closely the ES model fits the observations that we have made of individual stars over the years. If it does fit, the Electric Sun model is more properly called the Electric ***Star*** model.

At the beginning of the twentieth century, astronomer Percival Lowell was still looking for canals on Mars, and Harvard College Observatory's Harlow Shapley was developing his opinion that ours was the only galaxy in the entire universe. Edwin Hubble had just turned eleven years old. Most astronomers were still trying to categorize what little knowledge they had at that time about individual stars.

In 1900 we could only measure the distance to the closest stars. Astronomers used the 'parallax method.' This method of measuring distance is like looking at a nearby object as it appears against a more distant fixed background, first with one eye and then with the other. The object appears to have moved in relation to the background. If we know the distance between our eyes and can measure the angle through which the object appears to have

shifted, we can calculate the distance to the object. But instead of using the distance between their eyes as a base line, astronomers make two different observations six months apart so that the base-line distance between the observations is the diameter of Earth's orbit around the Sun.

Knowing the distance to a star enables us to calculate its 'absolute magnitude.' The absolute magnitude of a star is a measure of its luminosity that is independent of its distance. A star's absolute magnitude tells us how bright it would look if it were positioned 10 parsecs[128] away. That distance is used as the 'standard distance.' Thus we can really say, "This star is brighter than that star," not because it is closer to us, but because it really is brighter.

In 1911 Danish chemist–astronomer Ejnar Hertzsprung constructed a plot of the absolute brightness vs. temperature (spectral class) of the stars whose distances we could then measure with reasonable accuracy. In 1913 Princeton University astronomer Henry Norris Russell[129] independently repeated this exercise. This graph is therefore named the Hertzsprung-Russell (HR) diagram and is one of the basic topics presented in introductory astronomy courses. It is clear that the HR diagram is a plot of actual observations – not something deduced from theory. So any credible model of the workings of a star has to be consistent with it. Is the Electric Sun (ES) model of how a star is powered consistent with the HR diagram? If it is not, then this would falsify the ES hypothesis.

In the HR graph (Figure 41), as it is usually presented, the vertical axis is labeled with two scales: Absolute Magnitude (dim ones at the bottom running up to extremely bright ones at the top) and the ratio of the star's luminosity compared to our Sun's luminosity. The horizontal axis also is labeled with several scales:[130] One is Spectral Class which runs from left to right: O and B [blue], A [white], F [yellow], G [yellow-orange], K [orange], M [red]. Another one is Absolute Temperature, which also runs from left to right: from around 20,000 K down to 3000 K. These temperatures correspond to the spectral classes of those stars. A single given star defines a single point on this plot.

Our Sun, being a fairly typical star, falls almost at the center of the diagram (at Luminosity = 1 and Absolute magnitude = 5, Spectral Class G, and (photospheric) temperature = 6000K).

A major question is: Why do stars tend to group themselves together in

certain ways on this diagram? Most of the points on the plot fall along a diffuse line that snakes from the upper left down toward the lower right. The line falls quite steeply at the lower right end. There are two other, less populated, clouds of points: one group at the upper right and another one strung out across the bottom of the plot from a concentration in the lower left of the diagram.

In the ES model, perhaps the most important factor in determining any given star's characteristics is the strength of the current density in Amperes per square meter (A/m^2) measured at that star's surface. If a star's incoming current density increases, the arc discharges on its surface (photospheric tufts) will get hotter, change color (away from red, toward blue), and get brighter. The absolute brightness of a star, therefore, depends on two things: the strength of the current density impinging into its surface, and the star's size (the star's diameter). Therefore, we add another scale to the horizontal axis of the HR diagram in figure 41: "Current Density at the Star's Surface."

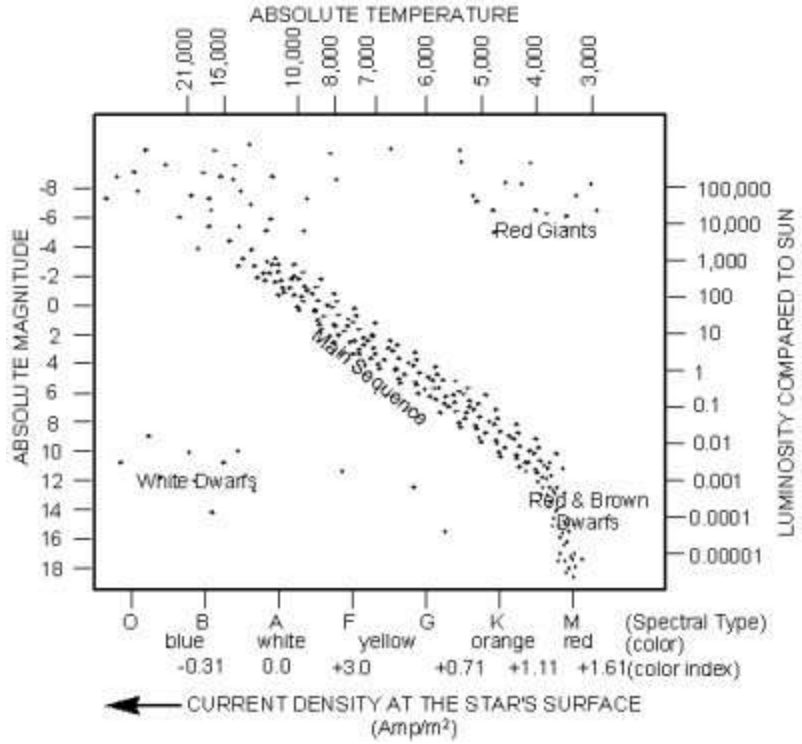


Figure 41: The Hertzsprung-Russell Diagram for nearby stars.

Consider moving from the lower right of the HR diagram toward the left. In so doing, we are moving in the direction of increasing current density

measured at the surface of each star. The first region on the lower right of the diagram is where the current density has such a low value that the plasma surrounding the (anode) star is not driven into the normal glow mode of operation, let alone arc mode. This is a region where only dark current plasma surrounds these objects.

This is the region of the brown and red ‘dwarfs‘ and giant gas planets. Recent discoveries of extremely cool L-Type and T-Type dwarfs have required the original diagram to be extended even farther to the lower right (See figure 42). These ‘stars’ have extremely low absolute luminosity and temperature.

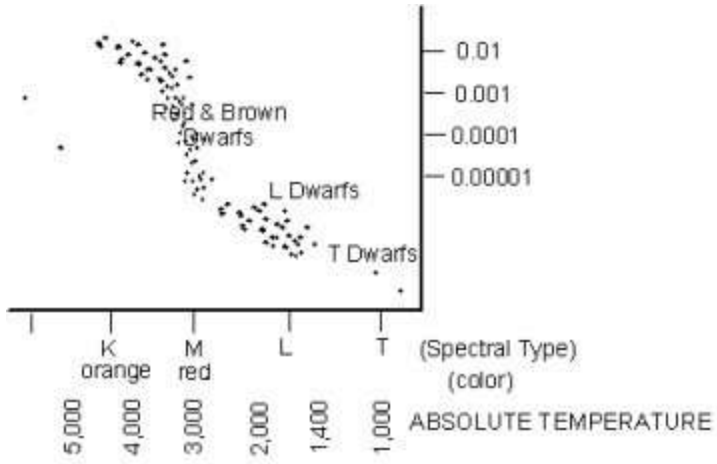


Figure 42: H-R Diagram extended to include LT dwarfs.

Notice that the surface temperature of the T-Type dwarfs is in the range of 1000 K or less. For comparison purposes, recall that some points on the surface of Venus are in the range of 500 K. T-Type spectra have features due mostly to methane — they resemble Jupiter’s spectrum. Such objects are anomalies for the standard model because they are much too cool and insufficiently massive to maintain fusion reactions at their centers.

In order for a nuclear fusion reaction to occur, standard theory requires that the temperature in a star’s core must reach at least three million K. And because, in the accepted model, core temperature rises with gravitational pressure, the star must have a minimum mass of about 75 times the mass of the planet Jupiter, or about 7 percent of the mass of our Sun. Many of the dwarfs simply do not meet these requirements. One astrophysicist, realizing this, has speculated that these dwarf stars must be powered by ‘gravitational

collapse.'[131] Nice try, but in reality, this is another observation that contradicts the fusion model of how stars are powered.

Astronomers say that brown dwarfs are 'failed stars.' Although the dwarfs cannot convert hydrogen to helium at these temperatures, they continue to emit faint light[132] as they slowly contract and cool during millions of years. Each of them supposedly ends its inglorious life with a whimper and finally fades into eternal insignificance. Proponents of the Electric Star hypothesis believe this is completely incorrect. It is the fusion theory that has failed, not the brown dwarfs.

The orbiting x-ray telescope Chandra recently discovered a brown dwarf (spectral class M9) emitting an x-ray flare. This poses an additional problem for the advocates of the stellar fusion model. A star this cool should not be capable of x-ray flare production. How 'gravitational collapse' can produce x-rays remains unexplained. "We were shocked," said Dr. Robert Rutledge of the California Institute of Technology in Pasadena, the lead author on the discovery paper to appear in the July 20 issue of Astrophysical Journal Letters. "We didn't expect to see flaring from such a lightweight object. This is really the 'mouse that roared.'"

In the ES model, there is no minimum temperature or mass requirement. If a brown/red dwarf is operating near the upper boundary of the dark current mode, any slight increase in the level of current density impinging on any portion of the surface of that star will shift this plasma into the normal glow mode. This transition will be accompanied by a rapid change in the voltage rise across the plasma of the star's upper atmosphere. Maxwell's equations tell us that such a change in voltage can produce a strong dynamic electric field and a strong dynamic magnetic field. If they are sufficiently intense, dynamic electromagnetic fields will produce x-rays. Another similar phenomenon will occur if a star makes the transition from normal glow mode to dark current mode. Typical arguments involving 'bow shocks' or 'gravitational collapse' are inadequate to explain how x-rays are generated in these proto-stars.

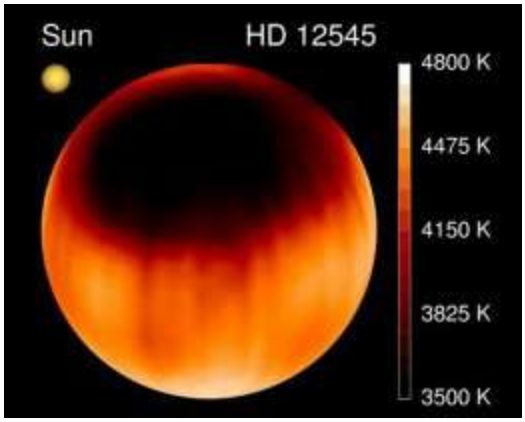
As we progress leftward from star to star in the HR diagram, the plotted points move steeply upward. We enter the spectral M range where some arc tufting becomes necessary to sustain the star's electrical discharge.

As current density increases, tufts (plasma in the arc discharge mode)

cover more and more of the surface of each star, and the stars' luminosities increase sharply — plasma arcs are extremely bright compared with plasma in its normal glow mode. Humans can look directly at neon signs but not at electric arc welders. In addition, arc discharges emit strong ultra-violet (UV) light.

This increasing tuft activity accounts for the steepness of the HR curve in the M region — only a slight increase in current density produces a large increase in luminosity. As we move upward and toward the left in the diagram, photospheric arcs (tufting) spread over the stars' surfaces until they are completely covered. A case in point: a recently discovered[133] star, HD12545, illustrated in figure 43, has half of its surface 'covered by a sunspot.' A more informative way of saying this would be that 'half of this star's surface is covered by photospheric arcing.' The present debate about the difference between a giant gas planet and a brown dwarf is pointless. They are members of a continuum. It is simply a matter of degree.

The intensity of the current density at their surfaces determines their appearance. NASA's discovery of HD12545 supplies the missing link between the giant gas planets and the fully tufted stars. In fact, this missing link fits into the ES model quite nicely.



Credit: K. Strassmeier (U. Wien), Coude Feed Telescope, AURA, NOAO, NSF

Figure 43: A star with only a partial photosphere.

Continuing toward the left, up beyond the 'knee of the curve,' all stars (K through B) are completely covered with tufts (have complete photospheres), and their luminosity no longer grows as rapidly as before. But the farther to the left we go (the higher the current density), the brighter the tufts become,

and so the stars' luminosities continue to increase. The situation is analogous to turning up the current in an arc-welding machine.

The increasing brightness of the arcs accounts for the upward slope of the line toward the left. Mathematically, the variable plotted on the horizontal axis (current density) is proportional to one of the factors affecting the quantity plotted on the vertical axis (luminosity). The more direct this relationship is, the more closely the plot will approach a 45-degree straight line.

All else being equal, a larger star will be brighter than a smaller one. Thus, the dispersion (stars located slightly above and below the line) is due to their variation in size. This relatively straight, rising portion of the HR diagram is called the 'main sequence.'

What kinds of stars are at the upper left end of the main sequence? This is the region of brilliant O-type, blue-white, high-temperature (35,000+ K) stars. Their absolute luminosities approach 100,000 times that of the Sun. These stars are under extreme electrical stress – excessive current densities impinge on their surfaces. That extreme electrical stress can cause such stars to split, perhaps explosively. Plasma cosmologists call this process 'stellar fissioning'; astronomers call them novae. An analogy to this is when we turn up the current in an electric arc welder to such a great extent that we fracture the piece we are working on.

Binary Stars (Fissioning)

Sixty-one percent of the sixty nearest stars are components of a double (binary) or triple star system.[134] Wal Thornhill relates this fact to the nova process:

> Internal electrostatic forces prevent stars from collapsing gravitationally and occasionally cause them to 'give birth' by electrical fissioning to form companion stars and gas giant planets. Sudden brightening or a nova outburst marks such an event. That elucidates why stars commonly have partners and why most of the giant planets so far detected closely orbit their parent star.

The cause of stellar fissioning may also be external. We have said a star is a ball of plasma. As such, the ions and electrons within it have (random)

thermal velocities. If the incoming electric current density increases so that the drift velocity of those particles exceeds the value of the thermal velocity, this produces a double layer (DL). The DL may move down into the plasma (into the star). At this position the DL can act much like a membrane that divides a biological cell. If the current density increases to too high a value, the DL may explode, splitting the star into two or more parts. A kind of stellar mitosis would result.

If a sphere of fixed volume divides into two smaller (equal sized) spheres, the total surface area of the newly formed pair will be about 26% larger than the area of the original sphere.[135]

Consider a massive blue-white star whose properties place it in the extreme upper left hand corner of the HR diagram. It is under intense electrical stress – the current density impinging on its surface is incredibly strong. So, to reduce the current density it is experiencing, an electrically stressed star may explosively fission into two or more stars. This provides an increase in total surface area and, thus, results in a reduced level of current density on the (new) stars' surfaces.[136] Although the ***total*** incoming electric current is unchanged, each of two new (equal sized) stars will experience only 80% of the previous current ***density*** level and therefore both will jump to new locations farther to the lower-right in the HR diagram.

A possible example of two equal sized offspring might be the binary pair called Y Cygni. This is a pair of giant O or B type stars that orbit each other in a period of a mere 2.99 days. Each star is some 5 million miles in diameter and 5000 times as luminous as our Sun. The stars are approximately 12 million miles apart (less than 2.5 times their diameters). Their masses are 17.3 and 17.1 times the mass of our Sun.

If the members of a resulting binary pair turn out to be unequal in size, the larger one will probably have the larger current density – but still lower than the original value. (This assumes that the total charge and total driving current to the original star distributes itself onto the new stars proportionally to their masses.) In this case, the smaller member of the pair might have such a low value of current density as to drop it, abruptly, to 'brown dwarf' or even 'giant gas planet' status. That may be how giant gas planets are born (and often found in such close proximity to their parents).

An interesting statement in this regard appeared in the January 1, 2001,

issue of *Science Now* magazine. In the article “An Awkward Trio Disturbs Astronomers” (p.4), G. Schilling wrote:

> Astronomers are scratching their heads over a strange new planetary system. A team discovered a huge gas ball — apparently a failed star called a brown dwarf — circling a star that holds another planet in its sway. But no one understands how something as massive as a brown dwarf could form so close to a normal star with a planetary companion.

The final distribution of matter and current density is sensitive to the mechanics of the splitting process. Such a process can only be violent – possibly resulting in a nova eruption. Some matter may be lost to the plasma cloud that later can appear as a planetary nebula or nova remnant that surrounds the binary pair.

If the charge on the original star is highly concentrated on or near its surface, and the fissioning process is similar to peeling off an onion’s outer skin, then most of that original charge (and current) may end up on the offspring star that is constituted only of the skin of the original star.

In this way the smaller member of the resulting binary pair might be the hotter one. In any event, both stars will move to different positions in the HR diagram from where their parent was located. An example of this type of pairing is the star T Corona Borealis.

Whatever form the splitting process takes — whether it is like a biological cell mitosis (that evenly divides the matter into two parts) or the ‘onion skin’ process described above — the two newborn stars will each have an initial velocity outward, away from each other. Therefore the paths of each, as they orbit a common center, will be highly elliptical. Many binary stars and extra solar planets have highly elliptical, small-radius orbits — much to the consternation of cosmologists who wonder how accretion disks could produce this.

Astronomers report that as we progress up the HR diagram from right to left, the maximum spin rates of stars increase. At the lower right of the main sequence, M-, K-, and G-type stars have never been observed to rotate more rapidly than approximately 5 km/sec. Our Sun (type G2V) rotates at its equator at about 1.7 km/sec. A tabulation of maximum rotation rates of the various spectral classes is shown below.

From an electrical standpoint we make the simple observation that ***increasing electric current input to stars results in increasing maximum rotational speeds.*** Whether this increased rotational speed adds to the stress on blue-white stars, escalating the likelihood of their fissioning, is conjectural at this point.

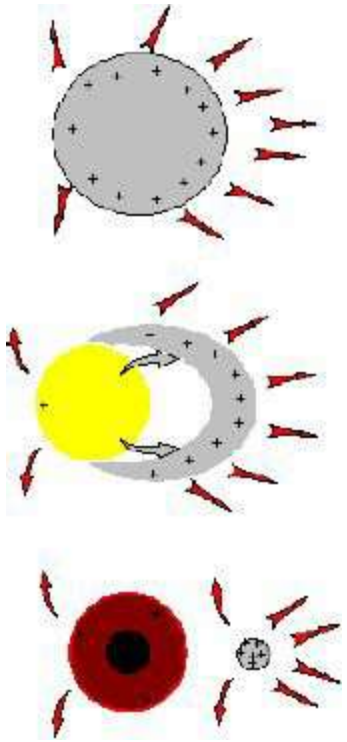


Figure 44: ‘Onion-skin’ fissioning.

Spectral Class	Color	Maximum Rotation (km/sec)
O, B	Blue, Violet	500
A	Blue-white, White	250
F0 to F2	White	250
F5 to F8	White	70
G	Yellow	5
K	Orange	5
M	Red	5

Stellar Evolution Counter-Examples

Accepted astronomical theory describes how stars must ‘age’ (run out of nuclear fuel) and slowly migrate, taking millions of years to do so, tracing meandering paths from one location on the HR diagram to another (the star going from one spectral class to another). The paths that these stars “must take” are, of course, completely predicated on the assumption that stars are fueled by the various stages of nuclear fusion of the lightest elements. The paths of stellar evolution are derived from what we presently know about nuclear fusion in its various stages.

The ES model does not make that assumption. In any event, humans have not been around long enough to actually observe any stars making the slow migrations from one place on the HR diagram to another that classical theory predicts. So, at present, slow ‘stellar evolution’ is another one of those complicated theoretical constructs that astrophysicists have devised without any observational evidence of its actual existence. There are, however, an increasing number of counterexamples — stars that have ***not*** evolved according to accepted theory. The following is a listing of some of these stars.

FG Sagittae

The star FG Sagittae breaks all the rules of accepted stellar evolution. FG Sagittae has changed from blue to yellow since 1955. Quite recently it has taken a deep dive in luminosity. FG Sagittae is the central star of the planetary nebula (nova remnant?) He 1-5. It is a unique object in the sense that, for this star, we have direct evidence of stellar evolution, but in a time scale comparable with the human lifetime.

> Around 1900 FG Sagittae was an inconspicuous hot star (T = 50,000 K) of magnitude 13. During the next 60 years it cooled to about 8000 K and brightened in the visual region to magnitude 9, as its radiation shifted from the far-UV to the visual region. Around 1970 a new bunch of spectral lines appeared due to elements such as Sr, Y, Zr, Ba and rare earths.... The star cooled further in the 1970s and 80s and then all of a sudden in 1992 its magnitude dropped to 14. Further

drops occurred from 1992 to 1996 with a very deep minimum near magnitude 16 in June of 1996.[137]

After abruptly brightening by four magnitudes, it has dropped seven magnitudes. From the end of the last century FG Sagittae has moved across the HR diagram changing from a normal hot giant to a 'late spectral type' (cool) star with marked changes in its surface chemical composition. Its present surface temperature is in the range of 4000K. This is not the slow stellar 'evolution' of classical astrophysics.

And ***FG Sagittae is a binary pair***.

The official wording was:

> In 1995 FG Sagittae changed in brightness in a quite sporadic manner from V~10.5 to ~13.0 according to the data by Hungarian Astronomical Association – Variable Star Section. During the spectral observations on 9/10 and 10/11 August, FG Sagittae was extremely faint: V~12.5–13.0, (according to Variable Stars Observers' League of Japan: ~13.3) and therefore erroneously the visual companion 8 arc-seconds apart from FG Sagittae was actually observed. This is probably the first high-resolution spectrum of the companion ever obtained. The spectrum turned out to correspond to a quite normal giant with the spectral type around K0.

Is FG Sagittae an example of the binary fissioning (caused by electrical stress) that was described above? It seems to have all the basic characteristics: nova-like ***brightening*** followed by ***loss of luminosity*** and ***loss of temperature***; moving to a ***different spectral type*** with marked changes in its surface chemical composition; discovery of a binary ***companion***; and the entire system lies within a nebulous nova ***remnant***.

V605 Aquilae and V4334 Sagittarii

Virginia Trimble, professor of physics at the University of California, Irvine, and visiting professor of astronomy at the University of Maryland, said recently:

> FG Sagittae was long seemingly unique. Examination of old images and spectrograms reveal that ***V 605 Aquilae***, studied by Knut Lundmark in the 1920's was a similar sort of beast, though it is now

very faint. And the latest recruit is ***V 4334 Sagittarii***, better known as Sakurai's object, for its 1994 discoverer. It, too, changed both spectral type and surface composition very rapidly, and is now hydrogen-poor and carbon-rich, and well on its way to becoming the century's third new R CrB star.

V838 Monocerotis

When Australian amateur astronomer Nicholas Brown photographed a region in the constellation Monoceros in early January 2002, he noticed a 10th-magnitude star that wasn't there when he'd photographed the same area about two weeks earlier. Over the next month, amateur and professional astronomers worldwide watched as this 'new' star brightened to magnitude 6.5 and then faded away again. Now a meager 16th-magnitude star, V838 Monocerotis (V838 Mon) was for a short time inherently brighter than any other star in our entire galaxy.

A few weeks after Brown's discovery, astronomers noticed that V838 Mon was surrounded by a glowing cloud. Over time, this nebulosity appeared to expand. On October 2, 2002, NASA's Astronomy Picture of the Day (APOD) announced what is to them another 'mystery star.' The official explanation reads, in part:

> V838 Mon was discovered to be in outburst in January of this year. Initially thought to be a familiar type of classical nova, astronomers quickly realized that instead, V838 Mon might be a totally new addition to the astronomical zoo. Observations indicate that the erupting star transformed itself ***over a period of months*** from a small under-luminous star a little hotter than the Sun, to a highly luminous, cool super giant star undergoing rapid and complex brightness changes. ***The transformation defies the conventional understanding of stellar life cycles.*** A most notable feature of V838 Mon is the expanding nebula which now appears to surround it. [Emphasis added.].

And ***V838 Monocerotis is a binary pair***.

One astronomer associated with the discovery said, "We are having a hard time understanding this outburst, which has shown a behavior that is not

predicted by present theories of nova outbursts. It may represent a rare combination of stellar properties that we have not seen before."

According to a group of observers who studied the star's spectra with the United Kingdom Infrared Telescope in Hawaii, V838 Mon appears to be the coolest super giant ever seen. At least 800 times larger than the sun, it had a surface temperature in March 2002 around 4,000 Kelvin — typical of a cool super giant star. But seven months later, it was much cooler. "It corresponded to a surface temperature little more than 1,000 Kelvin, well within the temperature range of brown dwarfs," says team member Mark Rushton of Keele University in the U.K. For mainstream astronomers, the additional finding adds to the 'mystery' surrounding V838 Monocerotis.

Again, exactly as in the case of FG Sagittae, we have an example of the binary fissioning (caused by electrical stress) that was described above. V838 Monocerotis seems to have all the basic characteristics: nova-like ***brightening*** followed by ***loss*** of luminosity and loss of temperature; moving to a ***different spectral type*** with marked changes in its surface chemical composition; discovery of a binary ***companion***; and the entire system lies within a nebulous ***nova remnant***.

Sirius

'The Dog Star' is the brightest star in our sky and is the alpha star in the constellation of Canis Major (The Big Dog) in the southern winter sky. Sirius is a main sequence, brilliant white A-type star. Its diameter is 1.8 times that of the Sun, but its luminosity is 23 times as great, which places its surface temperature at about 10,000 K. The ancients (among them: Cicero, Horace, Ptolemy, and Seneca) called it red or 'coppery' in color. Seneca, in the days of Nero, called it "redder than Mars," whereas he described Jupiter as "not at all red." However in the Tenth Century, Al Sufi did not include it among the stars he called 'red.' Presumably by that time the star had changed color from red to its present brilliant blue-white. Sirius has a small companion — so Sirius is also a binary star. The distance between the two is about 24 AU (24 times the distance from Earth to our Sun). The small companion is also an A-type star, but is extremely small — a 'white dwarf.' Castor

'The Horseman' is designated as the alpha star in the constellation of

Gemini, but it is not as brilliant as the beta star, Pollux. Castor is the 23rd brightest star in our sky while Pollux is the 17th brightest. The early astronomers always designated the most brilliant star in a constellation as ‘alpha,’ the second brightest was ‘beta,’ and so on. It has been suggested therefore that since the time of the ancients Castor has lost luminosity. When one examines the structure of Castor, one finds that it is composed of a triplet of stars, each one of which is itself a binary double. Thus Castor is made up of six small stars that slowly revolve about each other in a complicated dance. The three major components are called A, B, and C. Each of these is constituted as follows:

1. Two A-type main sequence stars rotating around each other in 9.2 days. Each component is twice the size of the Sun and 12 times its brightness.
2. Two A-type stars with rotational period of 2.9 days, separated by less than 3 million miles (3% Earth – Sun distance). Each component is about 1.5 times the Sun’s diameter and about 6 times its luminosity.
3. Also called YY Geminorum, consists of a pair of D-type red dwarfs that revolve around each other in 19.5 hours. They are separated by a distance of only 1.67 million miles (less than 7 times the distance between Earth and the Moon).

It appears that what remains of Castor is a celestial train wreck.

Capella

Capella is the brightest (alpha) star in the constellation of Auriga. It is approximately 45 light years distant. Several ancient and medieval writers, including Ptolemy and Riccioli described it as being a ‘red star.’ That description would put it into the type K or M spectral class. It has now been confirmed to be a binary — one G-type and one F-type, approximately 70 million miles apart (75% Earth-Sun distance), and the diameter of the G-type component is 13 times our Sun’s diameter. The F-type component’s diameter is 7 times our Sun. They revolve around each other in 104 days.

So now there are at least ***seven*** counterexamples — stars that do not slowly evolve according to the accepted thermonuclear model of how stars are powered. These are all stars that falsify the conventional understanding of

stellar evolution. Several of them act in a manner exactly predicted by the Electric Star fissioning hypothesis. All of them exhibit the rapid change in characteristics that is expected (or at least allowable) in electric stars but is impossible for stars powered by nuclear fusion.

In the Electric Star version of stellar evolution, things can happen quickly. If the fusion model were correct, it would take at least hundreds of thousands of years for a star to change from one place in the HR diagram to another. It would not be observed within a mere couple of thousand years much less within a human lifetime. It didn't take hundreds of thousands of years for FG Sagittae's energy to degrade. Modern humans have observed it doing so. The star V838 Monocerotis has moved half way across the Hertzsprung-Russell diagram in a few months. Both have now been discovered to be binary pairs. Migration across the HR diagram can happen relatively rapidly — and apparently does.

Red Giants

The diffuse group in the upper right hand corner of the HR diagram are stars that are cool (have low values of current density powering them) but are luminous, and so must be extremely large. Betelgeuse, the alpha star in Orion, is a red giant. It pulsates in size, the diameter changing by as much as 60% in value — from 480 to 800 million miles. This is 550 to 920 times that of our Sun. Its surface temperature is only about 1300 K. Its density is less than one ten-thousandth the density of our ordinary air here on Earth. Such a star has sometimes been called a 'red-hot vacuum.'

Red giants are highly luminous only because of their size. They are not necessarily any older than any other star. Notice that some are relatively quite cool — ***in the range of 1000 K***. How can stars at these low temperatures maintain an internal H→He fusion reaction? The simple answer is: They cannot. This, again, is a great puzzle to proponents of the fusion model. It is, however, perfectly understandable from the point of view of the Electric Star model. These stars are experiencing extremely low electrical excitation.

White Dwarfs

The stars grouped in the lower left hand corner of the HR diagram have low absolute luminosity but are extremely hot. The ES model simply explains them as being small stars that are experiencing high current densities. These are the 'white dwarfs.' Although most of them are concentrated in the lower-left corner of the diagram, the white dwarf group actually extends thinly across the bottom of the diagram. Thus the name ***white*** dwarf is a kind of misnomer if applied to the entire group. The shape of this thin grouping begins to drop off steeply at its (cooler) right end, much as the main sequence does.

Astronomers at NRL have been quoted[138] as saying:

> The observed white dwarfs are basically cooling embers. The nuclear fire of the stars burned out billions of years ago. The light emitted comes from the heat remaining from the earlier nuclear burning. By measuring the spectrum of the light, the brightness in various colors, the temperatures of the stars were determined. The two coolest of the white dwarfs studied, PSR J0034-0534 and PSR J1713+0747, are 3400 degrees Kelvin (5600 F), making them the coolest known white dwarfs. For comparison, the surface of the sun measures 5800 degrees Kelvin and the coolest previously known white dwarfs are 4000 degrees Kelvin.

But then why are these relatively cool stars called 'white'? One presumes it is only because they seem to be members of the grouping in the HR diagram that was originally given that name.

Spectral Lines

In a paper entitled 'Stellar Spectra,'[139] Dr. Earl Milton reported on research he had performed on spectral line broadening in 1971 while at the Dominion Astrophysical Observatory in Vancouver, British Columbia. This work provides strong evidence in support of the Electric Star model.

If a relatively cool gas comes between a wide-band light source and an observer, absorption lines will appear in the light's spectrum. These lines arise because of the absorption of (light) energy by the atoms of the gas. Electrons in those atoms jump from lower to higher discrete quantum energy

states – they get the energy to make that jump from the light (having exactly the frequency that corresponds to that energy gap) that is passing through the gas. Each element in the gas produces its own signature pattern of lines. By recognizing the line patterns, we can identify the gas that is causing them.

This method is used to discern what elements and molecules are present in the upper atmospheres of stars.

If, on the other hand, a sufficiently strong electric current is passed through a gas, the gas itself will emit a light spectrum in which only a few discrete colors (frequencies) appear. These are called emission lines. They are located precisely at those wavelengths (frequencies) at which that same gas produces absorption lines as described in the previous paragraph.

Absorption lines heavily dominate the spectra of most stars. Spectra from the cooler stars (such as types G and K) are dominated by molecular bands arising from oxides (such as ZrO and TiO) and from compounds of carbon such as CH, CN, CO, and C_2. Stars like the Sun (type G) show absorption lines from other 'metals.' As was pointed out earlier, the Sun shows the presence of 68 of the known elements. The spectra of hot O and B type stars show few lines, and what lines they do have appear quite blurred or 'broadened.' There are a few possible causes of this broadening.

If the absorbing gas is in a ***magnetic B***-field, each line may split, symmetrically, into multiple, closely spaced lines. This is called the Zeeman effect, named for its discoverer, Pieter Zeeman (1865-1943).

If the gas is in an ***electric E***-field, the lines split asymmetrically. This is called the Stark effect, named for Johannes Stark (1874-1957). These secondary lines are closely spaced in frequency (wavelength), and so the effect is sometimes called line broadening or blurring. A most important property is that the degree of Stark (electric field) broadening depends on the atomic mass of the affected gas. The lines of heavy elements are only slightly broadened, whereas those of lighter atoms and ions are quite smeared out. This effect is not noted in Zeeman (magnetic field) broadening.

As we progress from right to left up the main sequence in the Hertzsprung-Russell diagram – from the less electrically stressed stars toward those experiencing higher current input – we see an increasing broadening of spectral lines. In fact, at the upper left end (O-type stars) there is so much blurring that we can distinguish little structure in the line spectra. Is this

caused by the increasing strengths of the electric ***E***-fields in the stars' double layers as electrical stress increases? Is increased ***E***-field strength the ***only*** possible explanation for this line broadening?

Milton states that two pieces of evidence strongly indicate that the answer to this question is – yes, the line broadening in O-type stars is indeed caused by the Stark effect (due to the presence of strong ***electric fields***).

According to Milton, in highly stressed B-type stars:

> 1. A line at 4471.6 Angstroms is accompanied by a 'forbidden'[140] partner at 4469.9 Angstroms. It is well known that this latter line only occurs when an electric field is present.
> 2. There is an extreme difference between the degree of broadening of the lines from hydrogen and helium (light elements) and those arising from sodium and ionized calcium (heavier elements). This effect is only noted in Stark effect broadening.

The usual explanation of line broadening is that the star must be rotating rapidly – light from the limb going away from us is redshifted, and light from the limb coming at us is blue shifted – the total effect being to smear out the line widths. But, if that were the true cause of the observed broadening, the lines from hydrogen should be no more smeared out than those from calcium. Both of these observations (1 and 2 above) strongly suggest that the Stark effect is ***selectively*** broadening the spectral lines in B-type stars. And that clearly indicates the presence of ***strong electric fields*** above their surfaces.

There is no simple explanation of these spectral effects via the (non-electrical) thermonuclear core model. So, let us consider to what degree this phenomenon – the existence of spectral absorption lines and their selective broadening – is consistent with the Electric Star model.

In the Electric Star model the photosphere is the site of a strong plasma arc discharge. This produces the star's continuous visible light spectrum. Immediately above this, in the star's atmosphere, is the double layer (DL) in which an ***intense, outwardly directed electric field*** resides. It is within this strong ***E***-field that many heavy elements are created by z-pinch fusion. Recall that this strong electric field de-thermalizes the ions in that region, and thus it is the (relatively) coolest layer of the star's atmosphere. Light that originates in the photosphere passes through the relatively cool newly formed heavier elements in the DL. These heavier elements selectively absorb energy from

the light's spectrum, and thus the absorption lines are created. In fact, they are created in exactly the place where the star's ***E***-field is strongest. Thus we have the ideal situation for selective broadening of those lines due to the Stark effect.

In those instances wherein we see emission lines in a star's spectrum, we may speculate that, just as in the laboratory, the easiest way to generate them is by passing a strong electric current through a tenuous gas cloud. For example, type W (Wolf-Rayet) stars are under such intense electrical input that they are hotter even than type O stars. They are located to the left of the top of the Hertzsprung-Russell diagram. They typically show strong emission lines in their spectra. Since these stars experience stronger electric currents than any other type of star, there is ample probability that any tenuous coronal gases will be excited by such currents to produce emission lines.

At the other end of the HR diagram, type M (relatively cool) stars also sometimes exhibit spectral emission lines. Can we explain this via the Electric Star model as well? Again, consider the star Betelgeuse – a type M red giant. Remember that the average density of Betelgeuse is less than one ten thousandth of the density of the air we breathe. The outer 'surface' of this tenuous sphere (the radius of which is larger than the orbit of Jupiter from the Sun) has been found to have three bright areas of photospheric tufting above which we would expect to find DLs wherein z-pinch fusion may occur. It is from this source that the absorption lines in the M-type spectra come. But, in addition, a coronal plasma that extends out several hundred of its radii from the surface of the star surrounds Betelgeuse. This corona is even less dense than the star itself. Thus we have a gigantic, low-density plasma cloud through which (according to the Electric Star model) electric current is passing – an ideal situation for the production of spectral emission lines.

So, once again, in the case of stellar emission and absorption lines and their selective broadening, we observe a stellar phenomenon that is more consistent with the Electric Sun model than it is with the 'fusion core' model.

The Electric Star Model

A fresh look at the Hertzsprung-Russell diagram, unencumbered by the presumption that all stars must be internally powered by the thermonuclear fusion reaction, reveals an elegant correspondence between this plot and the

Electric Sun model proposed by Ralph Juergens and extended by Earl Milton. In fact, the correspondence is better than it is with the standard thermonuclear model. The proper name for this hypothesis then is **The Electric Star Model**.

The details in the shape of the HR diagram are exactly what the electric plasma star model predicts they should be. The observed actions of nova-like variable stars, the anomalies in the line spectra of B-type stars, and the high frequency of occurrence of binary pairs of stars are all in concordance with the Plasma/Electric Universe theory, the stellar fissioning concept, and the Electric Star model itself.

The behavior of FG Sagittae, V 605 Aquilae, V 4334 Sagittarii, and V838 Monocerotis is mysterious and unexplained by the thermonuclear model. Yet these phenomena are perfectly understandable using the ES model. We eagerly await the next 'mysterious star' discovery to further strengthen the case for the Electric Star hypothesis. In fact one can now predict with reasonable confidence that future discoveries of electric stress fissioning will include:

- A gamma-ray burst followed by
- A nova (visible light) eruption
- A star that rapidly changes its temperature, luminosity, and spectral type
- A remnant cloud or planetary nebula
- A resulting binary pair
- Possibly a pulsating ('pulsar') behavior from this pair
- Announcement of the discovery of yet another 'mysterious' star.

Figure 45 shows a sketch of the way the author and other plasma engineers suggest the Hertzsprung diagram should properly be plotted – with both Electric Current Density and Surface Temperature (as well as maximum rotational velocity) increasing from left to right.

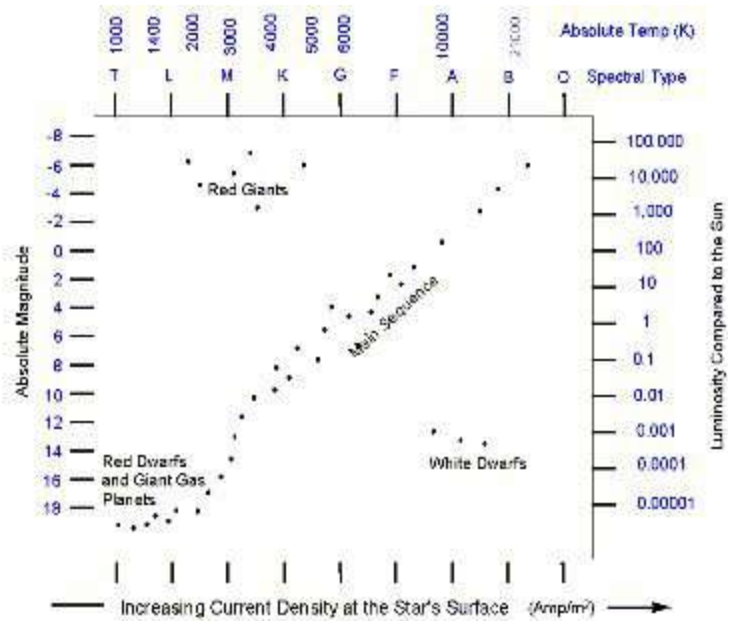
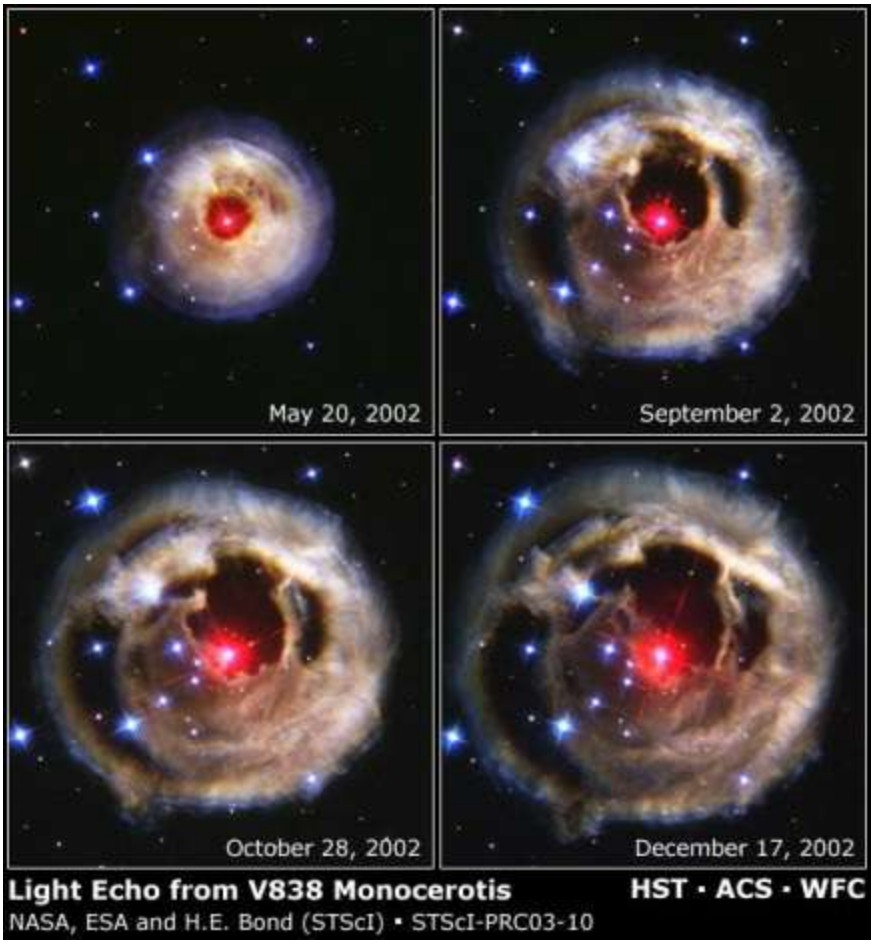


Figure 45: The Hertzsprung-Russell Diagram Drawn With Stellar Current Input and Temperature Increasing From Left To Right.

No, the stars are not electric lights, but they ***are*** balls of electric plasma, and the behavior of each of them is determined by the intensity of its electrical input. Turn up the current, and they get brighter and spin faster. They may even break up. Stars are obviously electrical phenomena.


May 20, 2002
September 2, 2002
October 28, 2002
December 17, 2002
Light Echo from V838 Monocerotis
HST · ACS · WFC
NASA, ESA and H.E. Bond (STScI) • STScI-PRC03-10

Credit: NASA, ESA, and H.E.Bond (STScI)

Plate 7: A seven-month evolution of the star V838 Monoceros.

Chapter 15

Stragglers, Bursters, and Pulsars

If we gaze up at the night sky carefully enough, we can see that the stars have subtle color differences. Some are visibly orange in hue – others a brilliant twinkling blue-white. We have discussed these various spectral classes in connection with the Hertzsprung-Russell (HR) diagram. But, there are many different ways to categorize stars in addition to their spectral class and size.

Population I and II Stars

While observing the Andromeda Galaxy, M31, astronomer Walter Baade discovered that he could distinguish between two general types of stars in that object. He called them Population I and Population II stars.

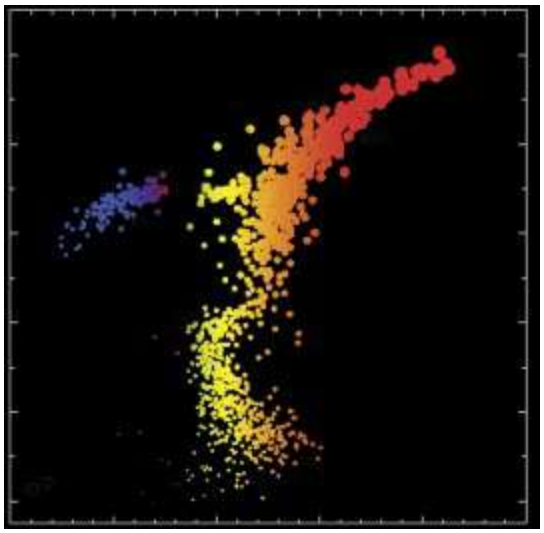
Population I stars are usually located in the arms of the galaxy. They are generally members of the main sequence of the HR diagram; they range from stars like our Sun to bright blue giants; and they usually have lots of dust, and gas in their vicinity. Astronomers call them ‘young’ stars.

Population II stars are usually found in the nucleus of the galaxy and in globular clusters that are situated around the galaxy’s periphery. These are less luminous stars – cooler, and with fewer heavy elements; many are red and yellow giants; and there is almost no dust and gas in their vicinity. Astronomers call these stars ‘old.’

So we see that there is roughly a left-half (Population I) – right-half (Population II) partitioning of the HR diagram. Therefore, from the Electric Star point of view, we note that the stars in Population I must be more heavily electrically stressed than those in Population II. The usual physical locations of these two star types in a typical galaxy are vastly different in electrical activity. In another chapter we will discuss the general shape of galaxies. Suffice it to say, the arms of galaxies (where Population I type stars are usually located) are the focus of strong Birkeland current densities.

Different HR Plots for Different Groups of Stars

Recently, HR plots of other more distant groups of stars have given quite different results from plots of the stars near our Sun. An example of this is the HR diagram for the globular cluster M5, shown in figure 46. This plot gives us possible clues to the structure of that star cluster. For example, current density (spectral type) seems to be roughly the same for many of the stars in M5, but their luminosity (size) varies widely. And the largest of these stars (ones near the top) seem to have the lowest current density. Are they at the center of the cluster and therefore somewhat shielded from the current? In another group of stars in M5 (the blue stars on the left), most of them seem to be of a similar luminosity (size) but with high and varying levels of current density. Are they the stars doing the shielding?



Credit: I. Smail, Department of Physics, University of Durham. And University of New South Wales

Figure 46: The HR diagram for the stars in globular cluster M5.

The different shapes of the HR diagrams for different groups of stars found in different places on the sky should not be thought of as being indicative of the ages of those stars or their interior composition or the evolutionary processes they are undergoing. Their position on the HR diagram depends only on their size and on the electrical stress they are experiencing. If the HR diagram were an accurate description of the evolutionary development of stars generally, then there should only be minor statistical variations among the shapes of plots obtained for different star clusters. Perhaps some clusters might lack certain classes of star, but the general shape of the diagram still ought to be recognizable, even if incompletely filled in with stars.

It is clear that the shape of the HR plot in figure 46 differs widely from the standard HR plot shown in figure 41.

Blue Stragglers

Until recently no O or B type stars (Population I) were observed in globular clusters. It was thought that all stars in globular clusters were of a similar age (old – Population II). Astronomers were shocked to discover some ‘blue stragglers‘ in certain clusters: these stars must not have aged ‘properly.’ They were “rejuvenated stars that glow with the blue light of young stars.” No one considered the scientific-method criterion that the observation falsified the theory of stellar evolution.

Another observation that contradicts the standard evolution model is the unexpectedly high amounts of blue and ultraviolet light emitted from the centers of elliptical galaxies (the other typical location of Population II stars). The standard model requires the stars in elliptical galaxies to be quite old. How can there be so many ‘young’ blue stars in them?

One traditional rationalization put forward to ‘save the theory’ proposes that some dying old stars suddenly decide to burn the helium they had been previously producing. Another is that perhaps there were collisions between stars. We have already discussed how improbable collisions are – so much so we can confidently call this an ‘excuse’ rather than an ‘explanation.’ Stellar densities in galactic nuclei are typically 50 to 60 stars per cubic light year. Each star occupies, say, 1/60 cubic LY. The cube root of 1/60 is approximately 0.25 – so, each star is 1/4 light year from its neighbor. (Remember Burnham’s model: Two specks of dust 1/100 inch in diameter separated by a distance of 1/4 MILE.) What is the probability of their colliding?

From the ES point of view, any star can move quickly, even jump, across the HR diagram if its electrical environment changes. Anyone who has seen the aurora’s plasma curtains moving and folding in the polar sky realizes that Birkeland current filaments are not fixed or static. They move around. If the galactic Birkeland currents move in space, they will likely move relative to some stars – either increasing or decreasing the current densities these stars experience. A blue star is just one that is experiencing the full brunt of a strong Birkeland current. Blue stragglers aren’t stragglers at all. They are just

blue.

Variable Stars

Then there are the ‘variable stars.’ When I was researching topics for this book, Wal Thornhill suggested,

> Have a look at variable stars, particularly bursters, where I think you will find the brightness curve is like that of lightning with a sudden rise time and exponential decay. Some stars are regular and others irregular. The irregular ones seem to average the power over the bursts. When they are more frequent, the energy is less per burst. If there is a long latency, the next burst is more powerful. It’s the kind of thing you would expect from an electric circuit when the trigger level is variable and the power input constant.
>
> I think many variable stars are actually binaries with some kind of electrical interaction. Long period Miras (a type of variable star) may actually have an object orbiting within the shell of a red giant

A recent Hubble image of Mira itself, the flagship star of that class of variable stars, reveals a huge plasma ejection on one side of the star. The official explanation includes the words,

> Mira A is a red giant star undergoing dramatic pulsations, causing it to become more than 100 times brighter over the course of a year. Mira can extend to over 700 times the size of our Sun, and is only 400 light-years away. The … photograph taken by the Hubble Space Telescope shows the true face of Mira. But what are we seeing? The unusual extended feature off the lower left of the star remains somewhat ***mysterious***. Possible explanations include gravitational perturbation and/or heating from Mira’s ***white dwarf star companion***. [Italics added.]

An electrical explanation of Mira’s pulsating output is that an electrical discharge is taking place between Mira and its companion, much like a relaxation oscillator. It’s not really mysterious at all.

There are many examples of unequally sized, closely spaced, binary pairs that are variable and emit frequent nova-like explosions. None of these pairs is easily explained by the accretion disk theory of star formation. The list

includes:

> • SS Cygni – A yellow dwarf and a hot blue-white dwarf – orbital period 6.5 hours with a separation distance a mere 100,000 miles or less. Burnham asks, “Is SS Cygni ... dying out after having been [a full scale nova] in the past?”
>
> • U Geminorum – A B-type blue dwarf and a G-type dwarf – orbital period 4.5 hours with a separation distance only a few hundred thousand miles. In this case Burnham states, “Spectroscopic studies reveal the existence of a ‘rotating ring of gas’ (plasma) around the blue star, and it appears that the explosive increase of light is due not only to the brightening of the star, but to a large increase of radiation from the cloud.”
>
> • Z Andromedae and R Aquarii – Both of these consist of a hot blue dwarf mated to a red giant.
>
> • T Coronae and RS Ophiuchi – Both have recurrent nova-like eruptions and are close binary systems.

On October 13, 1998, a NASA spokesperson explained:

> Cosmic gamma-ray bursts have been called the greatest mystery of modern astronomy. They are powerful blasts of gamma- and x-radiation that come from all parts of the sky, but never from the same direction twice. Space satellites indicate that Earth is illuminated by 2 to 3 bursts every day. What are they? No one is certain. Until recently we didn’t even know if they came from the neighborhood of our own solar system or perhaps from as far away as the edge of the universe. The first vital clues began to emerge in 1997 when astronomers detected an optical counterpart to a gamma ray burst. In February 1997 the BeppoSAX x-ray astronomy satellite pinpointed the position of a burst in Orion to within a few arc minutes. That allowed astronomers to photograph the burst, and what they saw surprised them.[141] They detected a ***rapidly fading star***, probably the aftermath of a gigantic ***explosion***, next to a faint amorphous ***blob*** believed to be a very distant galaxy. [Emphasis added.]

Doesn’t this sound like fissioning again? An explosion, followed by a rapidly fading star, accompanied by some sort of companion. Might it be that the reason they “never [come] from the same direction twice” is that the

creation of the binary pair has relieved the electrical stress (at least for a long enough time that we humans have not yet seen a recurrence)? The February 2001 issue of *Sky & Telescope* magazine contains these words:

> Does every gamma-ray burst begin with the supernova explosion of a massive star? New observations from NASA's Chandra x-ray Observatory and the Italian-Dutch BeppoSAX satellite suggest this is so. Some astronomers think it's still too early to draw firm conclusions, though they hail the new observations as revolutionary. In any case, a link between gamma-ray bursts and supernovae seems to be convincingly confirmed.

Pulsars

Another distinct category of variable stars is the pulsars. Pulsars emit exceptionally rapid flashes of energy. The first pulsar was discovered in 1967 by Jocelyn Bell and Anthony Hewish at Cambridge University's radio astronomy observatory (now the Nuffield Radio Astronomy Observatory). Most pulsars are detectable only by their radio frequency radiation. A few have rapid fluctuations in their visible light spectra.

Although pulsars do not occupy a specific place in the HR diagram, it is worth noting that they, too, have characteristics that are most comfortably explained via the ES model. The extraordinary thing about pulsars is the almost unbelievably high frequency of their flashes of electromagnetic radiation (both light and radio frequency emissions). When they were first discovered, it was thought that they rotated rapidly – like lighthouses. But when the implied rate of rotation for some pulsars was announced to be about once every second, despite their having masses exceeding that of the Sun, this lighthouse explanation became untenable. It was proposed that only such a super-dense material as 'neutronium' could make up a star that could stand those rotation speeds – so they *must* exist. A neutron star was spinning at the required rate.

Neutron Stars

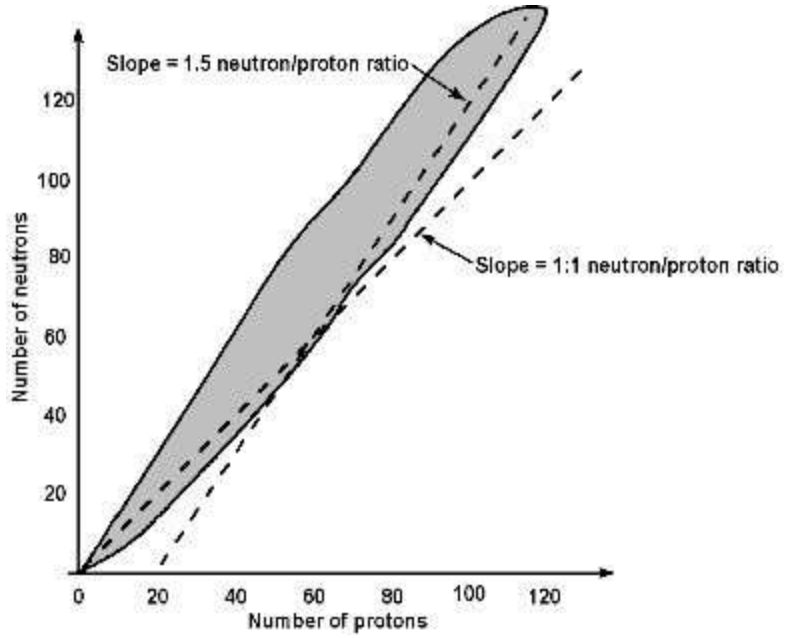


Figure 47: The neutron / proton band of stability.

Neutron stars are impossible. One of the well-known basic rules of nuclear chemistry is the so-called 'band of stability.' This is the observation that, if we add neutrons to the nucleus of any atom, we need to add an almost proportional number of protons (and their accompanying electrons) to maintain a stable nucleus. In fact, it seems that, when we consider all the known elements (even the heavy man-made elements as well), there is a requirement that, in order to hold a group of neutrons together in a nucleus, an almost equal number of proton-electron pairs are required. The stable nuclei of the lighter elements contain approximately equal numbers of neutrons and protons – a neutron/proton ratio of 1. The heavier nuclei contain a few more neutrons than protons, but the limit seems to be about 1.5 neutrons per proton. Nuclei that differ significantly from this ratio ***spontaneously undergo radioactive decay*** transformations that tend to bring their compositions closer to this ratio. Groups of neutrons are not stable by themselves.

A plot showing the number of neutrons and protons in the nuclei of all the known elements is shown in figure 47. Combinations outside the band ***are not stable***. Notice how narrow the band is. Neutronium (a nucleus made up of only neutrons) would have to lie somewhere on the vertical axis in this plot – and would therefore rapidly decay radioactively.

We know from laboratory experiments that any lone neutron decays into a

proton, an electron and a neutrino in less than 14 minutes; atom-like collections of two or more neutrons will fly apart almost instantaneously. There is no such thing as neutronium. Therefore there can be no such entity as a neutron star. It is a fiction that flies in the face of all we know about elements and their atomic nuclei.

Strange Matter

Perhaps some astronomers have begun to realize that neutronium is absurdly impossible. A less easily falsifiable entity has now been proposed. The discovery of an x-ray pulsar SAX J1808.4-3658 (J1808 for short), located in the constellation of Sagittarius, that flashes every 2.5 thousandths of a second (that would be **24,000 RPM**) goes way beyond the redline even for a neutron star. So another ad hoc explanation is added to the already long list – this pulsar must be composed of something even denser than packed neutrons – strange matter.

'Strange matter' is another non-falsifiable creation. "When you have excluded the impossible," said Sherlock Holmes, "whatever remains, however improbable, must be the truth." The difficulty comes in trying to distinguish between what is impossible and what is merely improbable. We know that neutron stars (made of neutronium) are impossible. Strange matter is also impossible unless we are willing to discard all that we know about the physics of materials here on Earth and invent 'new science.' The remaining explanation (however improbable astronomers may believe it to be) is an electrical one.

Electric Pulsars

Some pulsars oscillate with periods in the millisecond range. Their radio pulse characteristics are:

1. The duty cycle is typically 5% (i.e., the pulsar flashes like a strobe light – the duration of each output pulse, the time it is on, is much shorter than the length of time between pulses).
2. Some individual pulses are quite variable in intensity.
3. The polarization of the pulse implies that the origin has a strong

magnetic field. Magnetic fields require electric currents.

These characteristics are consistent with an electric arc (lightning) interaction between two closely spaced binary stars. Relaxation oscillators with characteristics like this have been known and used by electrical engineers for many years.

It is becoming obvious that pulsars are likely the result of electrical discharges between members of binary pairs: Using the Hubble Space Telescope, astronomers at the Naval Research Laboratory (NRL) have detected five optical companion stars orbiting millisecond pulsars. Three of the companions are among the coolest and oldest white dwarf stars known. One of the fastest pulsars discovered so far is named PSR B1937+21. Don Backer and Shri Kulkarni made the discovery of this first 'millisecond pulsar' at Arecibo in 1982. This remarkable star with a spin period of just 1.5578 milliseconds must rotate on its axis almost 642 times per second. In addition, some pulsars are known to be members of binary systems.

A rotation speed of 642 rotations per second is over **38,500 rpm**.

Some astronomers are quite willing to accept the possibility of a star rotating at 38,000 rpm. They say: "Some stars (named pulsars because of their specific characteristics) are known to rotate very rapidly. If a star with the density of our Sun were to spin as fast, it would fly apart. The only way these objects can stay together at those rotation rates is if they have a tremendous gravitational field, hence, are extremely dense. I see nothing wrong with accepting that there are densities in the universe that are much greater than in our solar system."

The only possible logical response to this is:

The entire question about densities is a red herring, e.g., it ***presumes*** that the emissions of pulsars are produced because of monstrously rapid rotational beacons – and then accepts any explanation that makes that possible.

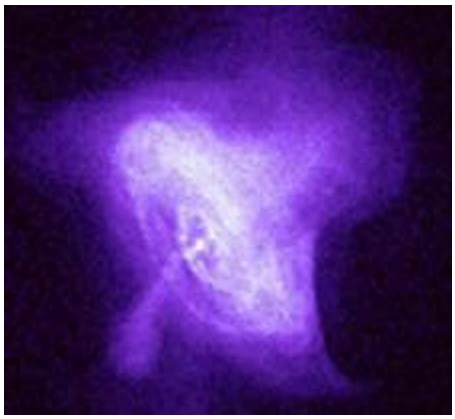
The bursts of radio frequency energy that are observed are quite short in comparison to the time between bursts. In other words they resemble radar signals. The pulsar emits a pulsed radio frequency signal whose modulation frequency is about 600 Hz. The phenomenon is produced electrically (much like a radio station). A relaxation oscillator can consist of two capacitors (stars) and a nonlinear resistor (plasma) between them. One capacitor charges up relatively slowly and, when its voltage becomes sufficiently high,

discharges rapidly to the other capacitor (star). The process then begins again. The rate of this charge/discharge phenomenon depends on the strength of the input (Birkeland) current, the capacitances (surface areas of the stars) and the breakdown voltage of the (plasma) connection. It in ***no way*** depends on the mass or density of the stars.

In the plasma that surrounds a star (or planet) there are conducting paths whose sizes and shapes are controlled by the magnetic field structure of the body. Those conducting paths are giant electric transmission lines and can be analyzed as such. Depending on the electrical properties of what is connected to the ends of electrical transmission lines, it is possible for pulses of current and voltage (and therefore power) to oscillate back and forth from one end of the line to the other. The ends of such cosmic transmission lines can both be on the same object (as occurs on Earth) or one end might be on one member of a closely spaced binary pair of stars and the other end on the other member of the pair similar to the 'flux tube' connecting Jupiter and its inner moon, Io.

In 1995 an analysis (and several super-computer simulations) was performed on a transmission line system having the properties believed to be those of a pulsar atmosphere. Seventeen different observed properties of pulsar emissions were produced in these experiments. This seminal work[142] by Peratt and Healy strongly supports the electrical transmission line explanation of pulsar behavior.

The Crab Pulsar – A Case in Point



Credit: NASA/CXC/SAO

Figure 48: Chandra x-ray image of the Crab pulsar.
The Crab Nebula (M1) is a cloud of plasma that is the ***remnant*** of a ***nova*** observed by Chinese astronomers. Lying at the center of the nebula is a pulsar – a star called CM Tauri. The frequency of repetition of the pulsar's output is 30 pulses per second. The length of each flash is approximately 1/1000 second, one millisecond. Is this star a binary pair? No companion is visible from even the largest earthbound telescopes.

But the Hubble orbiting telescope has recently found ***a companion*** – "a small knot of bright emission located only 1500 AU … from the pulsar. This knot has gone undetected up until now because, even at the best ground-based resolution it is lost in the glare of the adjacent pulsar. The knot and the pulsar line up with the direction of a jet of x-ray emission…. A second discovery is that in the direction opposite the knot, the Crab pulsar is capped by a ring-like 'halo' of emission tipped at about 20 degrees to our line of sight. In this geometry the polar jet flows right through the center of the halo."[143]

The discovery came from an image that was taken in the synchrotron light from the nebula – the light emitted by energetic particles spiraling in a strong magnetic field, i.e., an intense Birkeland current. Dr. Paul Scowen, research associate at Arizona State University, states, "The new data have provided a clearer glimpse at the pulsar environment; a glimpse that should have theoretical astronomers scratching their heads for some time to come." The shape of this pulsar-centered object is exactly that of an electrical homopolar motor – generator.

The Homopolar Motor

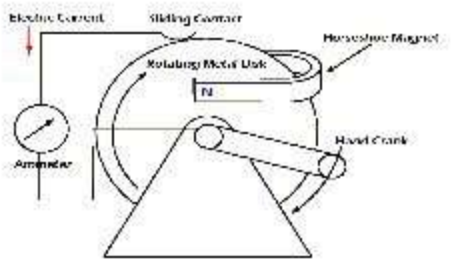


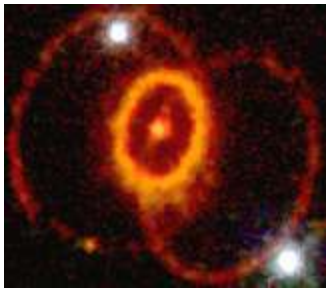
Figure 49: Faraday's Homopolar Motor Generator.

The general shape of a rotating disk carrying electric currents in the shape shown in figure 49 defines what is called the 'homo-polar motor.' In 1831 Michael Faraday was the first to use this mechanism[144] as a way to generate an electric current by moving a conducting path through a magnetic field.

When electric current is ***supplied*** to the disk, instead of being withdrawn from it, a mechanical torque is produced. Thus Faraday's device can be either an electric motor or a generator of electric power. The homopolar motor is the main element in the electric company's watt-hour meter on our homes. Its shape has been called a 'disk on a stick' or a 'doughnut on a stick.'

Not only does this effect explain the mysterious tangential velocities of the outer stars in galaxies, but also (in scaled down version) the observation that our Sun rotates faster at its equator than at higher latitudes. This is because a torque is applied ***to the equator of the Sun*** via the doughnut of plasma discovered by space probes.

This Faraday/homopolar motor mechanism also fits nicely with the observation, described earlier, that stars undergoing high electric current inputs (O-type, and B-type stars) have higher maximum rotational speeds. Putting more power into an electric motor makes it turn faster.



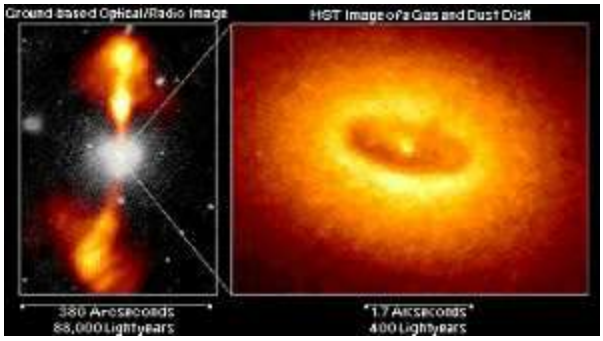
Credit: (ESA/ STScI), HST, NASA

Figure 50: SN 1987a.

This shape is unmistakable in the Crab image in figure 48. It is being seen with increasing frequency as more accurate and sensitive astronomical instruments are developed. Each of the images shown in figures 50 and 51 exhibits the homopolar disk shape.

On August 6, 2000, and October 15, 2000, the orbiting x-ray telescope Chandra discovered a pulsar at the geometric center of the supernova remnant known as G11.2-0.3. This observation provides strong evidence that the pulsar was formed in the supernova of 386 AD, which was also witnessed by Chinese astronomers. The official description of the image included the words:

> The Chandra observations of G11.2-0.3 have also revealed, for the first time, the bizarre appearance of the pulsar wind nebula at the center of the supernova remnant. Its rough cigar-like shape is in contrast to the graceful arcs observed around the Crab pulsar.



Credit: Hubble Space Telescope

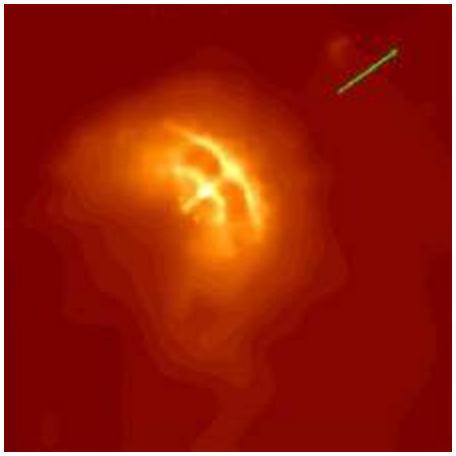
Figure 51: NGC 4261.

Upon examina-tion, the image of the central star reveals that it is at the center of a plasma discharge, not a ‘bizarre wind nebula.’ Although no binary companion has yet been found, the presence of the plasma discharge makes one suspect that such a discovery is only a matter of time.

Each new discovery of a binary pair of stars, one of which is either a variable star or pulsar, at the center of a nova remnant, is one more piece of evidence that supports the electric star model and the proposed theory of the fissioning of those electric stars.

The Astronomy Picture of the Day (APOD) on June 9, 2002, contained an image of another pulsar. It was entitled: “Vela Pulsar: Neutron Star-Ring-

Jet". The official explanation contained the following words:



Credit: G. Garmire et al. (PSU), NASA

Figure 52: Chandra image of the Vela pulsar.

This stunning image from the orbiting Chandra X-ray Observ-atory is centered on the Vela pulsar – the ***collapsed stellar core*** within the Vela super-nova remnant some 800 light-years distant. The Vela pulsar is a neutron star. More massive than the Sun, it has the density of an atomic nucleus. About 12 miles in diameter it spins ***10 times a second*** (600 rpm) as it hurtles through the supernova debris cloud.

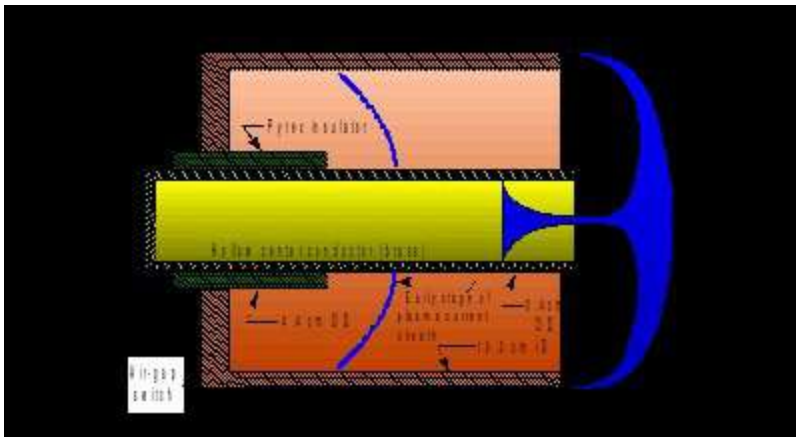


Figure 53: Plasma focus gun.

Notice the similarity of the exploding plasma shape obtained from a plasma focus device (figure 53) and the shape of the ejection from the Vela pulsar (figure 52).

Alfvén’s Electric Star Model

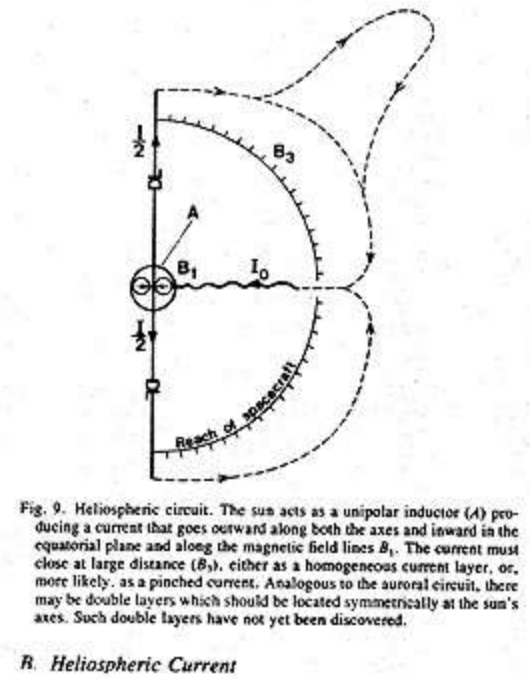


Fig. 9. Heliospheric circuit. The sun acts as a unipolar inductor (A) producing a current that goes outward along both the axes and inward in the equatorial plane and along the magnetic field lines B_1. The current must close at large distance (B_3), either as a homogeneous current layer, or, more likely, as a pinched current. Analogous to the auroral circuit, there may be double layers which should be located symmetrically at the sun's axes. Such double layers have not yet been discovered.

B. Heliospheric Current

Figure 54: Alfvén’s stellar circuit.

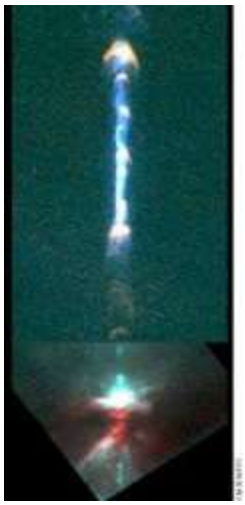
Hannes Alfvén, knowing that stars had many electrical prop-erties, proposed that each star was the center of an electric circuit. Once again, the plasmas involved may or may not be in one of the visible modes of opera-tion. For this reason not all images of stars show this structure – but many do. Alfvén’s ‘heliospheric circuit’ is shown in figure 54. It is clearly a homopolar motor. Because our Sun is a typical star, this diagram would apply equally well to it. The only caveat I would have with his model is in the location of the double layers. Alfvén shows the DLs to be positioned above the poles, whereas the ES model has them more evenly distributed over the surface. Also the current direction shown may indicate electron flow.

Alfvén’s proposal remained in the realm of conjecture until the spring of the year 2001 when the spacecraft Ulysses discovered long plasma (current carrying) ‘tubes’ emanating from the bottom pole of the Sun. These tubes are long enough to extend out farther than the distance of the planet Mars from the Sun.

The magnetospheres of the planets have depressions (some call them ‘holes’ or ‘cusps’) above their magnetic poles. This is where the electric currents from the Sun gain entry to the planets’ upper atmospheres and power the auroras. The solar magnetosphere likely has a similar pair of holes, this being where the Sun, in turn, connects electrically to the galaxy.

Of course, Alfvén believed all stars were jetted to some degree – but some less visibly than others. Figures 55 and 56 show the plasma jets and characteristic disk shape clearly.

Notice in figure 56 that the planets in this Herbig-Haro object are formed in a collinear array along the jet axis of the parent star. These clumpings are probably formed by DLs at those locations.

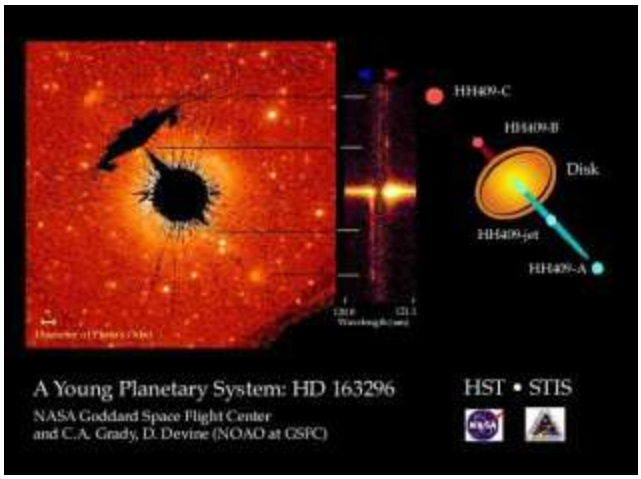


Credit: Bo Reipurth CASA/U. Colorado) et al., HST, NASA (Also from TPOD of 2/13/06) 60 Credit: NOAO/AURA/NSF

Figure 55: A ‘jetted’ star.

Thus, it should be clear that the ES model affords a simple understanding of these several different types of stars: binaries, variables, pulsars, jetted stars, and Herbig-Haro objects.

In the Electric Star hypothesis, there is no reason to attribute youth to one type of star over another. We conclude that a star’s behavior and appearance only depends on its size, whether or not it has a close companion, and the electric current density it is presently experiencing.



Credit: NASA Goddard Space Flight Center

Figure 56: A Herbig-Haro object.

Perhaps the most crucial insight provided by the Electric Star hypothesis is that, in the case of any star, conditions can change very quickly. This is disquieting because it indicates that our own Sun's future is not as blissfully certain as traditional astronomy predicts. We cannot know whether or when the Birkeland current powering our Sun will experience a surge or a blackout.

So, "The Sun will come up tomorrow" – probably – keep your fingers crossed.

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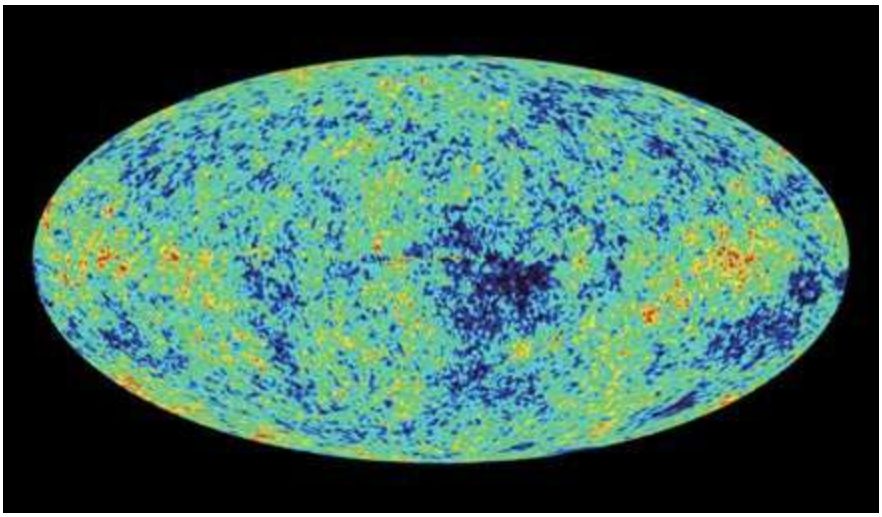


Credit: Credit: **WMAP Science Team, NASA**

Plate 8: An image of the entire sky made by the Wilkinson Microwave Anisotropy Probe (WMAP) showing the filamentary interconnectedness that permeates the cosmos. Establishment astronomers say this radiation comes from the deepest frontier of the expanding universe. But if that is true, large galaxies and galaxy clusters should be lighted from behind by this radiation and cast their silhouettes (shadows) on this image. Even after careful examination, no such shadows are observed. Thus it is probable this radiation originates from points much closer to Earth – perhaps within our own Milky Way galaxy. If so, yet another prop is removed from the Big Bang Theory.

Chapter 16

Galaxies

The typical response of anyone looking through a telescope at another galaxy for the first time is, Wow – Is that really an entire other Milky Way out there?

A galaxy is often called: ‘an island universe.’ The old underlying assumption is that it is a large aggregation of stars bound together by gravity. But new instruments and techniques have enabled us to detect electromagnetic radiation outside of visible-light frequencies. We can now recognize the electric and magnetic mechanisms that generate this radiation, and this has given us a better definition of what a galaxy is: ‘a vast structure of magnetized plasma clouds that contain electric currents and occasional widely distributed concentrations of what are called nebulae, stars, and – rarely – planets.’

There really are not as many stars in typical galaxies as people suppose. Physicist Richard Feynman once said, “There are 10^{11} stars in the galaxy. That used to be a huge number. But it’s only a hundred billion. It’s less than the national deficit. We used to call them astronomical numbers. Now we should call them economical numbers.”

Birkeland’s Prediction

Kristian Birkeland said,[145]

> According to our looking at the matter, every star in the universe would be the seat and field of activity of electric forces of a strength that no one could imagine. We have no certain opinion as to how the assumed enormous electric currents with enormous tension [voltages] are produced, but it is certainly not in accordance with the principles we employ in techniques on Earth at the present time. It seems to be a natural consequence of our points of view to assume that the whole of space is filled with electrons and flying electric ions of all kinds. We have assumed that each stellar system in evolutions throws off electric

corpuscles into space. It does not seem unreasonable therefore to think that the *greater part of the material masses in the universe is found*, not in the solar systems or nebulae, but *in 'empty' space*.

Birkeland thus predicted, back in 1908, that we would find vast amounts of plasma in space. We have. He stated that the mass of the galaxies is predominantly plasma not solid planets and stars. It is. And he predicted the existence in 'empty' space of electric forces "of a strength that no one could imagine." Now, in the Twenty-First Century, we are seeing evidence of them. Birkeland was correct.

Alfvén's Electric Galaxy Model

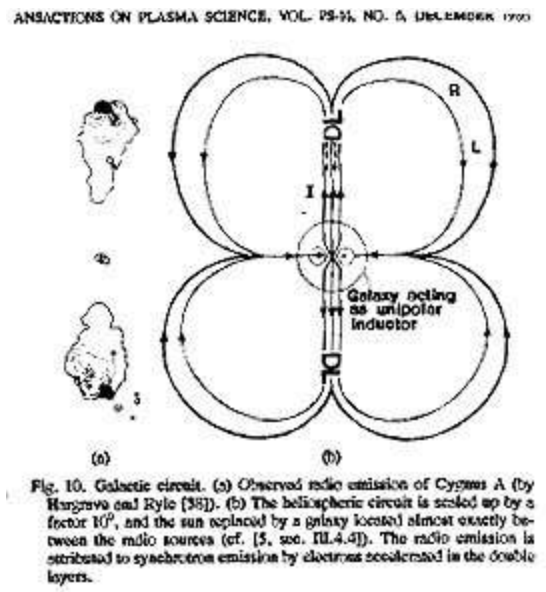


Fig. 10. Galactic circuit. (a) Observed radio emission of Cygnus A (by Hargrave and Ryle [38]). (b) The heliospheric circuit is scaled up by a factor 10^9, and the sun replaced by a galaxy located almost exactly between the radio sources (cf. [5, sec. III.4.4]). The radio emission is attributed to synchrotron emission by electrons accelerated in the double layers.

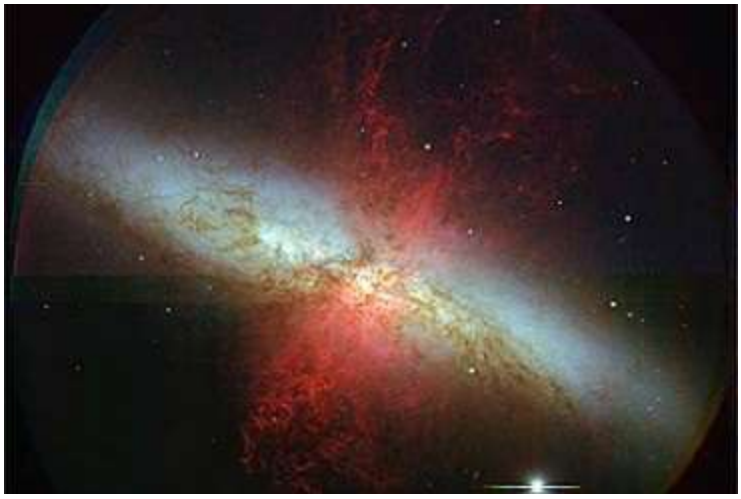
Figure 57: Alfvén's Galactic Circuit.

Hannes Alfvén first described the morphology (general shape) that characterizes most galaxies in 1986. His diagram is shown in figure 57. It is a vertical cross-section of a three dimensional shape. The horizontal line at the center of the diagram is actually a circular disk lying in the horizontal plane.[146] When this disk is viewed face-on, not from the edge as it is here, it has the familiar spiral or elliptical form of a galaxy that we are used to seeing. The parallel vertical lines coming out from the center of the galaxy (along its

axis of rotation) represent strong electric currents in a plasma that sometimes are visible. Astronomers call them ‘jets.‘

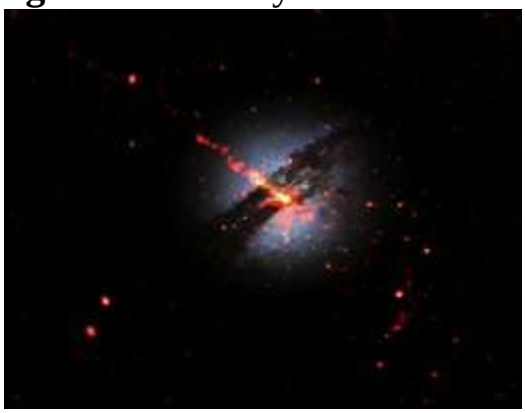
The letters DL in the sketch are double layers positioned within the ‘jet’ plasma. Recall that DLs contain strong ***E***-fields and are the source of radio frequency emissions. The two amorphous shapes at the left of the diagram ((a) in figure 57) are radio-telescope images of the typical ‘double radio source’ that is observed in many galaxies. These sources are due to the DLs.

In some galaxies the jet plasma is in the dark current mode; in others it is clearly visible.



Credit: FOCAS, Subaru 8.3-m Telescope, NAOJ

Figure 59: Galaxy M82 in infrared.



Credit: X-Ray image: NASA/ CXC/ SAO
Optical image: AURA/ NOAO/ NSF

Figure 58: Combined image of Centaurus A.

Figure 58 shows the radio source Centaurus A. It is also called galaxy NGC

5128 and Arp 153. It is a ‘double radio source’ exactly in conformation with Alfvén’s circuit in figure 57. The jet within which the radio sources are located is clearly visible in this image. Recall that DLs are the locations of strong electromagnetic z-pinches[147] that can compress dispersed material into denser objects.

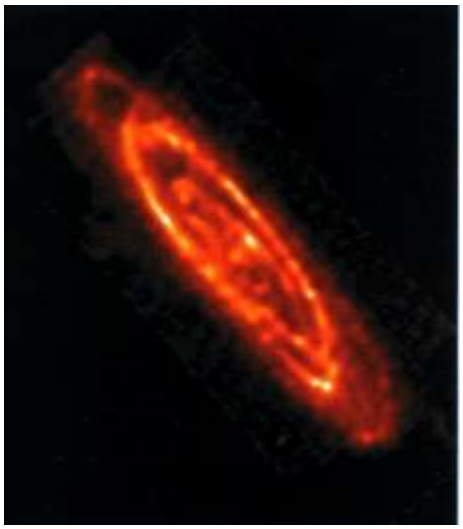
In many galaxies, the jet structure cannot be seen in visible light. So, until the devel-opment of infrared and x-ray orbiting satellite telescopes, most of these features remained undiscovered. There are now many images of galaxies that show the Alfvén structure.

The magnificent image in figure 59 was taken of galaxy M82 by the Subaru orbiting infrared telescope. It provides an excellent picture of the homo-polar structure.

Credit: NOAO/AURA/NSF

Figure 60: The Andromeda Galaxy, M 31. Visible light image.

Even our neighboring Andromeda galaxy, M31, shows the disk-like structure of the homopolar motor–generator morphology. Recently a string of dwarf galaxies has been found along its spin axis.[148]



Credit: ESA

Figure 61: M31 in infrared light.
Figure 60 is a normal, visible-light photograph of M31. Figure 61 is an image of that same galaxy obtained by the Infrared Space Observatory (ISO) operated by ESA.

Accretion Disks

The question arises – how are stars formed and grouped into these communities we call galaxies? We have mentioned that a popular concept in standard cosmology is the accretion disk. The assumption is that a spinning cloud of gas dust particles, under the influence of gravity, coalesces into a star, planet, or galaxy. Any question about how the spinning disk loses its angular momentum is usually met by an embarrassed silence.

Like a twirling ice skater who brings his arms more and more closely in toward his body and thus spins faster and faster, the contracting cloud would spin faster as it grew smaller. This increased spin rate would counteract the collapse.

In any event, one continually hears from professional astrophysicists that the accretion process forms stars and galaxies. Dr. Anthony Peratt[149] has commented about this accepted but hypothetical process of star formation:

> Accretion disks can be placed in a category with black holes and neutron stars. They don’t exist. They don’t even exist in computer simulations and calculations. The astrophysicists have access to the

same computers as I and cannot create them.

> You do not need an accretion disk [to show how stars or galaxies can be created] and you cannot make one. But you can hypothesize it. You can ***hypothesize*** that a miniature black hole also is the clock mechanism in your wristwatch instead of an electrically driven crystal oscillator.

Despite Peratt's insightful comment above, some work has recently been published on accretion disk simulation. But the simulation involved a plasma, not just gas and dust. "The simulation shows the complicated structure that arises from turbulence generated in the disk by the action of magnetic fields in the ***fully-ionized disk plasma***."[150] [Emphasis added.]

Stellar Strings

It is becoming clear that the formation of galaxies and the stars within them are due to electric plasma phenomena and not to a collapse of dust clouds driven solely by gravity. The z-pinch effect of Birkeland currents and its accompanying compression of matter[151] can squeeze even neutral (un-ionized) matter together to form stellar objects.

In almost any deep sky image, we can see that stars form in strings. Those strings are most probably the pathways followed by cosmic Birkeland currents. Look at any wide-angle photograph of stars in our Milky Way galaxy, and you can see that stars tend to be located along string-like paths.

For example, in the image of galaxy NGC 891 shown in figure 62, one can see several stars-in-a-string arrangements in the foreground stars. These foreground stars are located within our Milky Way galaxy, not the background galaxy. These are examples of what Peratt refers to as the filamentary structure of the cosmos that is predicted by plasma cosmology.

For years, astronomers have dismissed these apparent strings as optical illusions created in any random aggregation of points. But now they are becoming less dismissive: Case Western Reserve University astronomers have announced their discovery of a string of stars that has wound itself around our galaxy like a strand of spaghetti. A consortium of researchers from three continents – called the Spaghetti Collaboration – found new evidence suggesting the existence of three more star strings in the outer

regions of our galaxy. “It is exciting news to know that there are star streams in the outer galaxy, and things are messier, more beautiful, and more dynamic than originally thought,” says Heather Morrison, an astronomer at Case Western Reserve.[152]

Galaxy Strings

Image by the author.

Figure 62: Edge-on galaxy NGC 891, also showing star strings within our galaxy in the foreground.

Galaxies too appear to be arranged in galaxy strings. The length of some of these strings of physically related galaxies is much larger than 10 to 15 billion light-years. But Big Bang cosmologists claim that the entire universe is only 13 or 14 billion years old. How can a structure have a larger dimension in light-years than the age of the universe in years? There would not be enough time for it to get that large.

This is like saying: An automobile with a maximum speed of 100 mph that rolled off the assembly line right here where we are standing exactly one hour ago is now more than 100 miles away. If it ***is***, there is a lot of explaining to do.

The late astrophysicist John Bahcall has said, “The results on large-scale structure … cause difficulties for theories of structure formation when considered together with explanations of the structure on smaller scales (galaxy correlations and properties) and the absence of structure in the microwave background. Both the quantitative measure of the clustering of [galaxy] clusters … and the suggested bulk velocities on large scales are

difficult for most current models to explain."[153] I think he is realizing he has a lot of explaining to do.

Astronomer Charles Steidel of Cal Tech, who has developed a method for observation of very faint galaxies, has discovered galaxies that are, by the assumed redshift-distance relationship, more than 12 billion light-years from us. These galaxies are not randomly distributed but show considerable clustering.[154]

In early 2004, a press release was published that revealed more about discord among cosmologists concerning the Big Bang Theory than it did about the 'news' of galaxy strings, which were by then fairly well known:

> Galaxy Find Stirs Big Bang Debate – Thursday, January 8, 2004.
> SYDNEY, Australia (CNN) – An Australian-led team of scientists has discovered a new string of galaxies which they say challenges existing theories about the evolution of the universe.
> The team, using telescopes in Chile and in Australia, detected the galaxies about 10.8 billion light years away in a remote region of the universe, the Australian National University's Research School of Astronomy & Astrophysics said in a statement Thursday.
> With light traveling at 9.5 trillion kilometers in one light year, this means the galaxies are being observed as they appeared 10.8 billion years ago, the statement said.
> The universe was formed during the Big Bang about 3 billion years earlier – 13.7 billion years ago – so the find could give more clues about what went on in the universe when it was one-fifth of its present age.
> Thirty-seven of the brightest galaxies were detected, including a quasar, but thousands of galaxies were probably in the string, according to astronomer Dr. Paul Francis who heads the team.
> But none of the existing computer simulation models were able to reproduce galaxy strings as large as the one the team found.
> "We are looking back four-fifths of the way to the beginning of the universe and the existence of this galaxy string will send astrophysicists around the world back to the drawing board to reexamine theories of the formation of the universe," Francis said.

> “The simulations tell us that you cannot take the matter in the early universe and line it up in strings this large. There simply hasn’t been enough time since the Big Bang for it to form structures this colossal.”

The statement also said that the researchers – who were funded by NASA and the Australian National University – were refused the use of a telescope in the United States ostensibly because the observations to be carried out were considered ‘technically impossible’[155] by many American astronomers.

The team has presented its findings to the American Astronomical Society.

Further surveys to map an area of the sky ten times greater than the team’s observation are underway. This would provide a clearer picture of the large-scale structure, the statement said.

William Mitchell quotes a Big Bang proponent as having said, “It is not the Big Bang that is having problems, the problems are with galaxy and structure formation. The structure problem has nothing to do with the Big Bang.”

Mitchell then quotes Anthony Peratt, “The Big Bang theorists attempt to decouple themselves from the problem of galaxy formation. But one must ask what kind of cosmology is it that cannot account for galaxy formation in spite of their arguments that it is not their problem.”[156]

If galaxy formation is not within the purview of cosmologists, into whose purview does it fall? Does this admission demonstrate that cosmologists consider their ‘purview’ to be only higher mathematics divorced from any empirical concerns? Has cosmology now finally and completely decoupled itself from being concerned with reality?

Peratt has shown that galaxy string formation occurs naturally and predictably via plasma interaction with cosmic Birkeland currents and their associated magnetic fields. Once again, plasma cosmology has answered the enigmatic questions of how galaxies are formed, why they form in strings, and why they rotate as they do. It has also predicted the filamentary nature of the cosmos. Galaxy strings are a direct consequence of the filamentary makeup of electric plasma in deep space.

Thus, we now can see why galaxies are not simply collections of stars. They are constituted mainly of plasma – and their shape and observed

dynamic behavior are the result of natural electrical forces acting on that plasma.

Some Types of Galaxies

In addition to classifying galaxies simply by their shape: spiral, elliptical, lenticular, etc., some other descriptions are also used:

Seyfert Galaxies: In 1943 Carl K. Seyfert described a class of galaxies whose central regions have peculiar spectra containing strong **emission lines**.

AGN objects: Active Galactic Nuclei. These exhibit **high x-ray luminosity**. The source of the huge amounts of energy radiated by these galaxies is still a matter of debate among astronomers.

Starburst galaxies: A starburst galaxy is one that is supposedly experiencing a period of intense **star forming** activity.

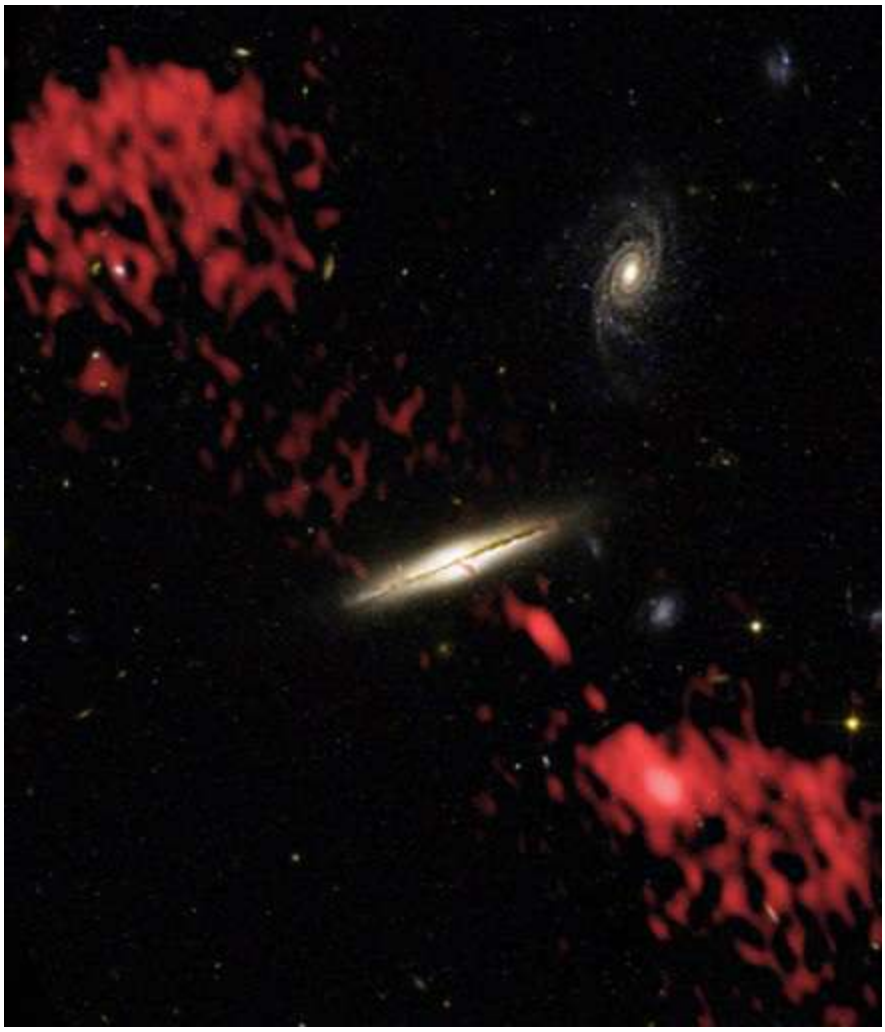
BL Lac objects: BL Lacertae objects (BL Lac for short) are galaxies that exhibit **no emission lines** but have a strong continuum spectrum stretching from radio frequencies through X-ray frequencies. They can exhibit dramatic variability. The name remains from an original misidentification of the prototype of such galaxies as being a variable star within our own galaxy that was given the name BL Lacertae. Finally it was realized that this object was

not a single star but actually a distant galaxy with peculiar properties. The name stuck to the class of objects exhibiting the same features.

Quasars: The spectra of most stars are relatively smooth and contain a few absorption lines; **quasar spectra possess a number of strong emission lines**, the most prominent being the Lyman alpha transition of neutral hydrogen. The usual wavelength of the Lyman alpha line is in the far ultraviolet (1216 Angstroms). Many quasars have extremely high redshift values in which that line is shifted down to the infrared end of the spectrum.

ULIRGs: UltraLuminous InfraRed Galaxies radiate most of their **energy in the far infrared**. Whether or not all ULIRGs host an active nucleus is not clear. Currently astrophysicists claim that there is an evolutionary link between ULIRGs and AGNs.

ULX objects: The UltraLuminous X-ray sources (also called IXOs, Intermediate X-ray Objects) are a population of small objects with **X-ray luminosities** lower than an active galactic nucleus (AGN). It is not clear yet what their nature really is.



Credit: W. Keel (Univ. Alabama), M. Ledlow (Gemini Obs.), F. Owen (NRAO), AUI,NSF, NASA

Plate 9: Galaxy 0313-192. The plasma clouds (in red) to the upper left and lower right of the central galaxy are double layers making this object a ‘double radio source’ galaxy. Hannes Alfvén predicted this shape many years before any such objects were discovered. See figure 57. The smaller spiral galaxy in the upper right is not associated with the foreground object.

Chapter 17

Redshift and the Big Bang

In the mid 1920s, astronomers had not yet realized that each of the faint 'spiral nebulae' that they had observed through their telescopes was really another galaxy in its own right. They believed that the stars of the Milky Way marked the extent of cosmic space. In 1920 Harlow Shapley (1882-1975), at that time the Director of Harvard College Observatory, still maintained[157] in a public debate that these spiral nebulae were clouds of gas and dust within our Milky Way galaxy. He asserted that those faint swirls of luminosity would eventually shrink down to form new stars and solar systems.

Assertions made without much in the way of hard evidence to back them up are always precarious. Michael Faraday stated it this way: "I could trust a fact, but always cross-examined an assertion." Shapley's unsupported assertion would soon be proven wrong.

In 1924, astronomer Edwin P. Hubble used the 100-inch telescope at Mt. Wilson to measure the distance[158] to one of the nearest 'spiral nebulae' – M31, known today as the Great Andromeda galaxy. He was also able to measure distances to a few other nebulae. They were hundreds of thousands of times farther away than the most distant stars in our Milky Way galaxy. Shapley's 'spiral nebulae' were other island universes – separate galaxies much like the Milky Way.

Not surprisingly, Hubble found that generally there was an inverse relationship between the apparent brightness of each of those galaxies and their distance from us. The farther away from us one was, the dimmer it appeared. Of course, this is exactly what anyone would expect: if it was farther away, it was dimmer. But the obverse question was never asked: If it is dimmer, does it have to be farther away? Couldn't it be just a small dim galaxy near us?

If the absorption or emission lines in the spectrum of the light from a star or galaxy appear at a lower frequency (shifted toward the red) than where they are observed in the spectrum of a laboratory experiment, astronomers say this object has 'positive redshift.'[159] The first galaxy Hubble measured,

M31, was found to be ***blue***-shifted, but by 1925[160] redshifts predominated in the list he had compiled. In 1929 Hubble announced that there was a linear relationship between redshift and the galactic distances[161] he had measured. The dimmer a galaxy was, the more its light was shifted toward the red end of the spectrum – the higher its 'redshift' was.

Because of Hubble's work, the inference was universally drawn that '***redshift implies distance***.' But one question still remained unasked: Could many of the dimmer galaxies whose distance had not been directly measured be just small, weak galaxies relatively near to us? Did they have to be big galaxies located very far away? The question was ignored.

It was also assumed that if an object's light exhibited a high redshift value, this implied that the object was speeding away from us. Why did astronomers conclude that?

The assumption that redshift is caused by a body's moving away from us is drawn by analogy to the well-known Doppler effect in sound waves – the downward shift in the pitch of a train whistle as it passes through a railroad crossing and speeds away from us. It sounds reasonable. Light, just like sound, is a wave and, as such, we can measure its frequency. If the source is receding away from the observer, the frequency that is measured (of light or sound) will decrease. But, can things other than the Doppler effect also cause redshift?

There are really two different important questions that must be answered by astronomers:

Is the redshift phenomenon a useful tool in measuring the recessional velocities of stars and galaxies?

Is recessional velocity the ***only*** cause that can produce a redshift?

It has become clear that the answers to these questions are: 1) Yes, provided you are careful about how you do it, and 2) an emphatic no. Astronomers have only concentrated on the first one. They ignore the second.

Although Hubble saw an apparent relationship between redshift and ***distance***, he did not feel that redshift was necessarily caused by an object's ***velocity***. He said it might be, but he felt that the relationship of redshift to velocity had not been demonstrated by observation – at least not clearly enough to accept it as a universal truth. In everything he said and wrote about redshift, Hubble always used the qualifier 'if.'

"*If* the redshifts are a Doppler shift ... the observations as they stand lead to the anomaly of a closed universe, curiously small and dense, and, it may be added, suspiciously young. On the other hand, *if* redshifts are *not* Doppler effects, these anomalies disappear and the region observed appears as a small, homogeneous, but insignificant portion of a universe extended indefinitely both in space and time."[162]

But the analogy between the Doppler effect in sound waves and the observed redshift in light was so compelling to astronomers that they quickly dropped Hubble's cautionary 'if.' The directly measured value of redshift, *z*, was routinely converted to a Doppler velocity.[163] Astronomers reported redshift values of observations in terms of recessional velocities as though they had measured them with a speedometer instead of a theory. To resist this hidden implication, astronomer Fritz Zwicky insisted on using the term 'indicative velocity.'

Nevertheless, the notion that 'redshift implies recessional velocity' became astronomical dogma. But it is only a dogmatically held ***assumption***. In fact, because of relatively new evidence, it is becoming clear that a high positive redshift value does *not* imply that an object is moving rapidly away from us – or even that it is extremely distant.[164]

Yet another conclusion was cantilevered onto all this: if objects are moving away faster in proportion to their distance, then running time backward will bring the objects together at a single point in space sometime in the past. The expanding universe theory was born. Everything must have started with a Big Bang.

But if a high redshift value does ***not*** necessarily mean the object is moving away from us and is far away, then what does it signify? Could there be another cause of high redshift values? If so, ***that*** would suggest the universe is not necessarily expanding – that there was no Big Bang.

Dr. Halton C. Arp is a professional astronomer who began his career as Edwin Hubble's assistant. Arp has earned the Helen B. Warner Prize, the Newcomb Cleveland award, and the Alexander von Humboldt Senior Scientist Award. For years he worked at the Mt. Palomar and Mt. Wilson observatories. While there, he assembled his well-known *Catalog of Peculiar Galaxies* – galaxies that are misshapen or irregular in appearance.

Figure 63: Dr. Halton C. Arp

While compiling his catalog, Arp discovered that many pairs of quasars (‘quasi-stellar objects,’ or QSOs), which have enormously high redshift values, are physically associated with galaxies that have low redshift values.

These quasars are symmetrically located on either side of, and usually near the spin axis of, what he suggests are their parent low-redshift galaxies. According to astronomical doctrine, the high-redshift quasars must be located at the far edges of the universe, and the low-redshift galaxies must be relatively close by.

The astronomical establishment reflexively explains away Arp’s observations of connected galaxies and quasars as being ‘lensing illusions’[165] or ‘coincidences of apparent location.’ But the large number of physically closely associated quasars and low-redshift galaxies that he has photographed and cataloged defies that evasion. It happens much too often to be a chance association.

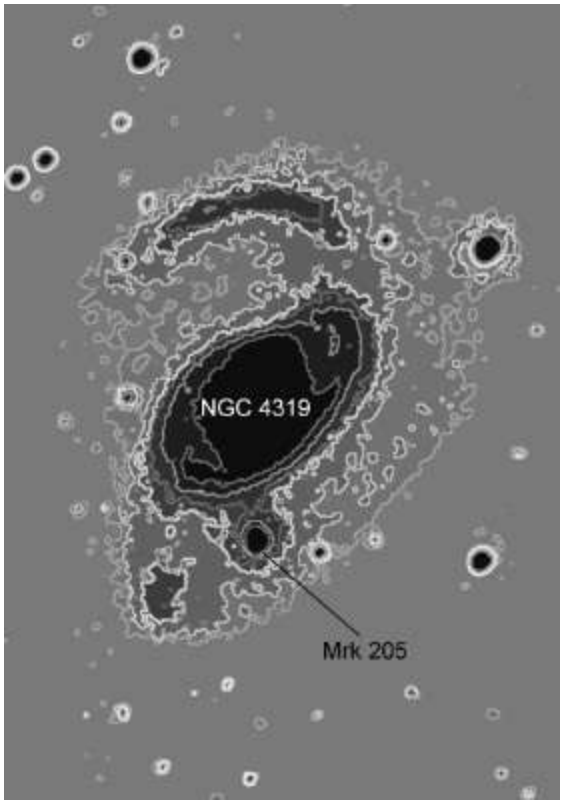
Arp has also photographed actual physical connections between low-redshift galaxies and higher-redshift companion galaxies. If two objects are connected, they cannot be cosmically distant from one another. It is just that simple. Arp’s photographs disprove both the ‘redshift equals distance’ and ‘redshift equals recessional velocity’ assumptions.

Researcher Amy Acheson pointed out:

> Halton Arp’s observations show that the assumption that high redshift implies velocity never really was valid. Arp shows, one galaxy grouping at a time, that the smaller and fainter (high-redshift) galaxies

really are smaller and fainter, but not necessarily farther away. They are connected to, interacting with, and possibly ejected from the larger and brighter (low-redshift) galaxies. The expanding universe theory fails because higher redshift isn't only a measure of velocity. High redshift is an intrinsic property of small faint (recently born) galaxies. As the galaxy grows and evolves, the redshift changes. The light from high-redshift faint galaxies has traveled the same distance as the light from their low-redshift parent galaxies.

Because of Arp's photos, the assumption that high-redshift objects have to be far away – which motivates the Big Bang theory and all of presently accepted expanding-universe cosmology – is demonstrated to be wrong. It is a paradigm-shattering result.



Credit: John Smith – Hidden Loft Observatory

Figure 64: NGC 4319 and Markarian 205

A prime example of Arp's evidence is the connected pair of objects known as galaxy NGC 4319 and quasar Markarian 205. These two objects have vastly different redshift values.[166] Professional astronomers were quick to say that

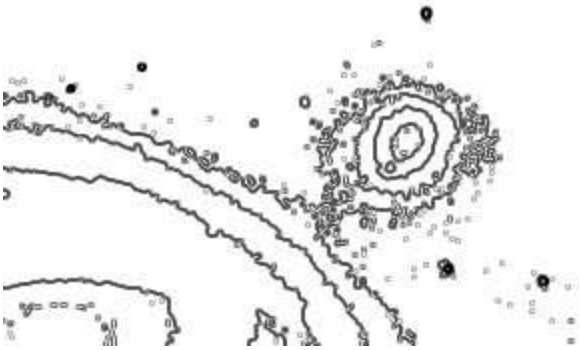
they “cannot see any physical connection” between these two objects. They have at their disposal the Hubble Space Telescope, the Chandra x-ray orbiting observatory, and all of the big scopes of Kitt Peak, Hawaii, and Chile. But they cannot see the connection that Arp saw. Lately they have admitted that there may be an “apparent” connection, but that it is only a “mirage.”

Of course, if there actually ***is*** a physical connection, then the Big Bang Theory is in trouble.

On April 4, 2002, amateur astronomer John Smith of Oro Valley, AZ, obtained an image of the two objects mentioned above: NGC 4319 and Markarian 205 (Mrk 205). I then quantized the light levels in that image to show isophote (similar brightness) contours. This result is shown in figure 64.

In that image, Mrk 205 is the small appendage below the main galaxy. It is clearly connected to the main body of NGC 4319.

In processing this image, I used level quantization (staircase gray curves in the Picture Window Pro 3.1 software package) followed by the ‘Edge tool.’[167] Notice that, of all the small objects surrounding the main galaxy, only Mrk 205’s shape is stretched back toward NGC 4319. None of the other objects in close proximity to 4319 is extended in this manner.



Credit Original Image: R. Knacke (Penn State Erie) et al., Hubble Heritage Team, NASA

Figure 65: Isophotes from the HST image of NGC 4319 and Mrk 205.

On October 7, 2002, the Astronomy Picture of the Day (APOD) published an HST[168] image of these same objects. The orientation is different, but the connection is again clearly visible. After processing the HST image exactly as was done with the first amateur image, I obtained the image shown in figure 65. It is obvious the larger galaxy (NGC 4319) in these images is physically connected to its small companion quasar. Notice, in figure 65, the

three small clumps of matter situated along the line connecting the center of Mrk 205 to the larger galaxy.

The official explanation of the NASA image states:

> Appearances can be deceiving. In this NASA Hubble Space Telescope image, an odd celestial duo, the spiral galaxy NGC 4319 [center] and a quasar called Markarian 205 [upper right], appear to be neighbors. In reality, the two objects don't even live in the same city. They are separated by time and space. NGC 4319 is 80 million light-years from Earth. Markarian 205 is more than 14 times farther away, residing 1 billion light-years from Earth. The apparent close alignment of Mrk 205 and NGC 4319 is simply a matter of chance.

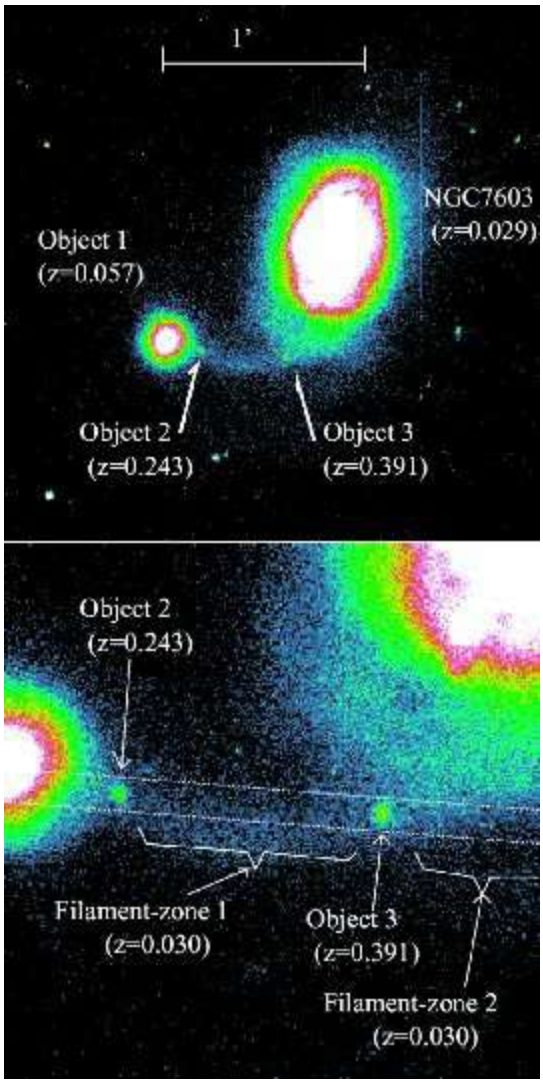
Establishment astronomers deny that there is any physical connection between this pair and assert that the obvious bridge between the two objects 'must be' an illusion. But this 'must be' only arises from their predilection to believe in a cherished theory despite empirical evidence. When a pair of amateur astronomers such as John and myself are able to get and process images that the professionals 'cannot see,' one has to wonder whether those experts are just being stubborn in defense of their assumptions or are in a psychological state of total denial. Interestingly, the HST image of NGC 4319 and Mrk 205 was obtained under the amateur HST request program that NASA had been supporting for a long time prior to when this image was downloaded. Very soon afterward, the request program was terminated.

In his first book[169] Arp says that a favorite practice of his detractors is to look for absorption lines in the spectrum of the low-redshift (supposedly closer) object that correspond to emission lines in the quasar. This, they say, proves that the quasar is behind the low redshift galaxy. But when such absorption lines are ***not*** found, this could just as well be interpreted as proof that the quasar is in ***front*** of the galaxy. In the case of NGC 4319 and Mrk 205, no such announcement was made. Arp knew they had looked for the absorption lines, spending a great deal of time with the Hale 200-inch scope on Mt. Palomar doing so. At an open meeting of astronomers, he eventually asked about what had been found. Arp says in his book, "They replied that they had found no absorption. What seemed to me quite devastating was that they had to publicly admit that they had not published information gained from those enormous amounts of large telescope time, that they had withheld

this important scientific information, apparently because it did not agree with the position to which they were committed."

Recently it has been announced that absorption spectra have indeed been observed in NGC 4319 at the redshifted emission lines in Mrk 205. Arp's opponents say this proves that Mrk 205 is at an enormous 'cosmological distance' from Earth. But the observed lines are at an intensity of only about 10% of the absorption lines seen in control galaxy tests. Arp claims that this observation simply proves that Mrk 205 has not yet completely emerged from the disk of its ejecting parent, so we are seeing about 10% of that parent galaxy still in front of the quasar.

If this were the only piece of evidence, one might conclude that it was insufficient, on its own, to justify throwing out the Big Bang Theory. But Arp has more – much more.



Credit: Lopez-Corredoira and Gutierrez 2002 70a Credit Lopez-Corredoira and Gutierrez 2002 70b Credit: X-ray: NASA / CXC / INAF-Brera / G.Trinchieri et al.; Optical: Palomar Observatory / DSS

Figure 66: Galaxy NGC 7603 and Three Quasar Companions.

Another example of two or more connected objects that have different redshift values is galaxy NGC 7603 and the quasar that is linked to it by a bridge of luminous matter. If redshift really implies distance, then the bright companion quasar (Object 1) must be ***twice*** as far away as the main galaxy. However, in figure 66, it is obvious that the two are physically connected.

Furthermore ***two additional quasars*** have been discovered[170] inside the bridge of matter connecting Object 1 to NGC 7603. These are called Object 2 and Object 3 in the figure.

These two newly discovered objects have redshift values that establishment astronomers claim should put them ***ten or more times*** farther away

than NGC 7603. Yet all four objects are obviously in close proximity to each other. They are connected to each other. And they lie within the tail of matter leading off from the parent low redshift galaxy.

The discoverers of the new quasars have said:

> We present new spectroscopic observations of an old case of anomalous redshift – NGC 7603 and its companion [object 1]. The redshifts of the two galaxies which are apparently connected by a luminous filament are z=0.029 and z=0.057 respectively. We show that in the luminous filament there are two compact emission line objects with z=0.243 and z=0.391.
>
> They lie exactly on the line traced by the filament connecting the galaxies. As far as we are aware, this is the most impressive case of a system of anomalous redshifts discovered so far.

Eric Flesch[171] of Wellington, New Zealand, has commented on the discovery as follows:

> NGC 7603 has been described as "the most impressive case of a system of anomalous redshifts discovered so far." The configuration and redshifts are: two galaxies of different redshifts, connected by a luminous bridge, and where the bridge connects to each galaxy – precisely exactly at each of the two points – there is a higher redshift object. By virtue of the luminous bridge and the perfect positions of the two faint objects, it is unquestionable that these four objects are physically linked and sharing the same space.
>
> The point is that any scientific claim must be falsifiable. To hold that redshift is an absolute indicator of distance must be to allow standards of evidence that will overturn that position. NGC 7603 is evidence which meets that standard, and if it is not sufficient to overturn the standard model all on its own, it is strong enough to require addressing by the proponents of the standard model.

But again an important point is that these cases are not alone. Arp and his associates have collected ***hundreds*** of similar close associations of high-redshift quasars and low-redshift galaxies.

Arp has commented[172] on how a similar case was received by the professional astronomical community:

> A reasonable response would be to notice such a case and say, “If I see a few more cases like this I will have to believe it is real” Most astronomers say, “This violates proven physics [i.e., their assumptions] and therefore must be invalid. After all, no matter how improbable, it is only one case.” Then, when they see another case, they treat it *de novo* and reject it with the same argument. Professional scientists, however, have a responsibility to know about previous cases. And they do. When they block them out, it is a clear case of falsifying data for personal advantage – a violation of the primary ethic of science.

Arp applied to have the orbiting Chandra X-ray observatory look at these two new quasars. He announced in a paper[173] that he published in June 2004, “It must be noted, however, that an application to make an observation of NGC 7603 with Chandra was turned down; as a consequence we do not know if the two HII galaxies in the bridge are X-ray sources nor do we know what else this active Seyfert[174] contains.”

In *Quasars, Redshifts, and Controversies,*[175] Dr. Arp discusses the five interacting galaxies, NGC 7317, 7318A, 7318B, 7319, and 7320, that constitute what is known as ‘Stephan’s Quintet.‘ The last one, NGC 7320, has a redshift value of 800 km/sec. The other four have redshifts of either 5700 km/sec or 6700 km/sec.[176]

Astronomers claim those last four are seven to eight times farther away from us than is NGC 7320. Therefore, they say, there cannot be any interaction between 7320 and the others.

Dr. Arp states in his book, “The deepest 200 inch (Mt. Palomar) plates that I have been able to obtain clearly show a ‘tail’ coming out of the southeast end of NGC 7320.

“A tail like this from NGC 7320 ... must be an interaction tail – which could arise only from physical interaction with the adjacent high-redshift members of the Quintet.”

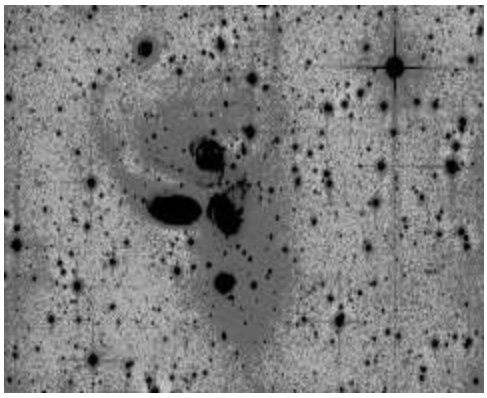
He then comments that at least one amateur has been able to see the tail but “it is amazing that so many professionals have difficulty seeing it.” NASA routinely crops their images of Stephan’s Quintet to exclude the area

where this tail is located.[177] Those familiar with the Galileo story will remember the priests who refused to look through his telescope at the night sky.

Credit: John Smith – Hidden Loft Observatory

Figure 67: Stephan's Quintet.

Amateur astronomer John Smith has taken a deep (long exposure), full, un-cropped image of the Quintet. This image is shown in figure 67. The large galaxy on the left side of the group is the low redshift (and therefore supposedly nearby) NGC 7320. Proceeding counter-clockwise from the lower right, we have NGC 7317, 7318A, 7318B, and 7319. The small galaxy at the top left is NGC 7320C. All the other objects are stars located within our Milky Way galaxy.



Credit: John Smith – Hidden Loft Observatory

Figure 68: Negative, digitally enhanced contrast, image of Stephan's Quintet.

This un-cropped image was then inverted, and put through a process similar

to the one described in the discussion of the HST NGC 4319–Markarian 205 image. The result is shown in figure 68.

It is apparent that an interaction 'tail' does indeed extend out from NGC 7320 toward the left (East).[178] In fact it appears to curve up toward and connect with the small, high redshift galaxy, NGC 7320C. Once again Arp has visual evidence of close interaction between objects having vastly different redshift values.

And again – if amateur astronomers can obtain and perform simple digital processing on an image such as this, then why, with the multimillion dollar facilities of NASA, Cal Tech, and Kitt Peak, can the professionals not do the same? The answer is that they can, but it is not in their self-interest to do so, because the results disprove their long accepted theories and endanger the continuation of their research-funding stream.

Let us consider yet another example of pairs of linked objects that have vastly different redshift values. NGC 1232[179] is also known as Arp 41. It is a magnitude 9.9 spiral galaxy with a small secondary spiral on the end of one of its arms. The small companion, NGC 1232A, has a redshift ***four times*** that of the large galaxy.[180] Under accepted theory, this requires the small companion to be over four times farther away from us than the large galaxy. Yet it is obviously positioned on the end of one of the main galaxy's arms.

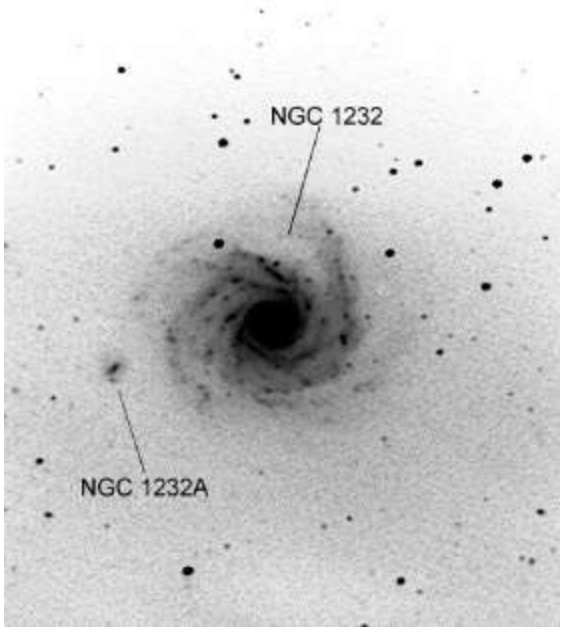


Image by the author.

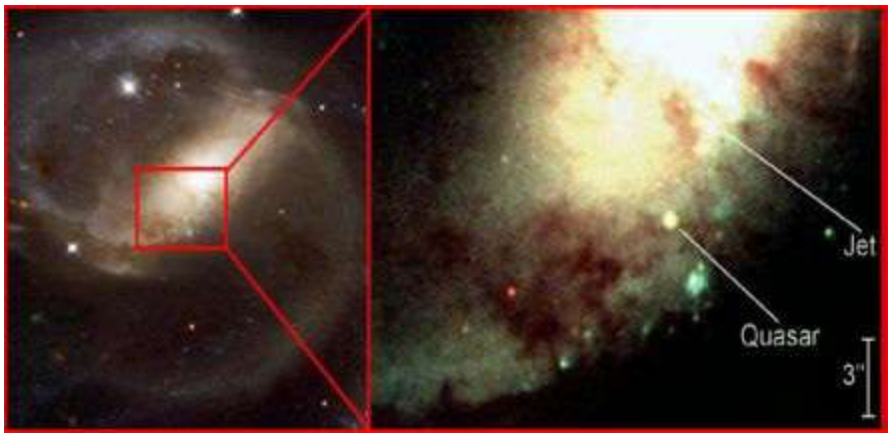
Figure 69: NGC 1232 and 1232A

If that were not enough, yet another small offspring galaxy has recently been discovered within the same arm of NGC 1232 that leads out to NGC 1232A. This new one has an extremely high redshift value. Arp states, “The most compelling argument that the [new] object was at the distance of NGC 1232 was simply that one does not see background galaxies through the disk of a spiral galaxy.”

Arp goes on to say, “This evidence, even though of the most detailed and quantitative kind, has always been simply ignored.” It appears that, when one discordant redshift rela-tionship is discovered, close examination of the immediate area often reveals one or more others.

Until recently, many of the quasars that Arp has found to be associated with nearby low-redshift galaxies have been in close proximity to those parent galaxies. He has presented statistical arguments to demonstrate that such close positioning could not arise from a uniform distribution of quasars over the sky. Mainstream defenders of the Big Bang throw up all sorts of probabilistic arguments against Arp’s connected objects.

One might think, however, that if anyone were ever to find a quasar directly in front of a bright, low-redshift galaxy, then that would clearly constitute absolute falsification of the notion that these high-redshift objects must be at their extremely remote ‘cosmological’ distances (as dictated by the redshift equals distance assumption).



Credit: Lopez-Corredoira and Gutierrez

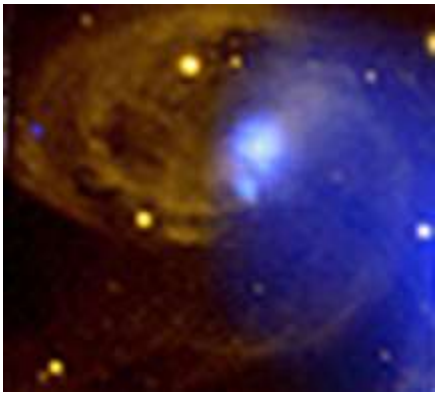
Figure 70a: A high redshift quasar located in front of low redshift galaxy NGC 7319.

Dr. Arp and his associates[181] ***have discovered just such a quasar*** (Figure

70a). It lies directly between Earth and galaxy NGC 7319 in Stephan's Quintet. It is indeed ***in front of*** its parent galaxy and is connected to it. The redshift of the quasar is 93.7 times that of the NGC 7319 galaxy that lies immediately behind it. But in accepted astronomy circles, this would mean the quasar is over ***93 times*** farther away from us than is the big galaxy. Arp *et al*. show in their paper that the quasar is interacting with the material in front of the galaxy. There is a jet of matter reaching out from the center of the galaxy toward the quasar.

The centers of Seyfert galaxies like NGC 7319 are opaque – we cannot see through them. We cannot even see into the cores of such galaxies let alone what is behind them. Thus, this quasar found superimposed on the face of this nearby low-redshift Seyfert galaxy obviously has to be closer to us than the galaxy. This discovery should force the final and absolute demise of the main assumptions that led to the Big Bang theory – the assumptions that high redshift implies great distance and recessional velocity.

Arp and his colleagues submitted a paper for publication announcing the discovery. For many months, the paper was 'discussed and re-reviewed' – to the extent that one can legitimately use the word 'stonewalled' – by editors of prestigious astronomical journals. However, the image shown here received wide circulation on the Internet, where it was viewed by an increasingly vocal number of amateur astronomers and other interested viewers. In my opinion, this widespread dissemination forced the Astrophysical Journal finally to publish it (2/10/05).



Credit: X-ray: NASA / CXC / INAF-Brera / G.Trinchieri et al.; Optical: Palomar Observatory / DSS

Figure 70b: X-ray image (blue) showing strong x-ray emission from the

vicinity of the QSO and the nucleus of NGC 7319.
I asked one of Arp's detractors about this picture, and he continued to put forward probabilistic doubts that we are seeing what we are obviously seeing. He said that even this picture was not proof the quasar was in front of the galaxy. Another astronomer opined that there "must be" a hole in the galaxy at just the right position so that we can see the quasar through it at its far 'cosmological distance.'

As of July 2006, several such images[182] of QSOs in front of the disks of low-redshift galaxies have been published.

Dr. Arp believes that quasars are ejected with large intrinsic redshift values from their parent galaxies. As they move away, their redshift decreases. Often, when the intrinsic redshift evolves down to a certain value, the quasar starts to look like a small galaxy or BL Lac object[183] and begins to fall back, with still decreasing redshift values, toward its parent. Any additional redshift (over and above its intrinsic value) is indeed indicative of the object's velocity. But the intrinsic component is an indication of the object's youth and usually makes up the larger fraction of the object's total redshift.[184]

Other plasma scientists, such as Dr. Anthony Peratt, dispute the 'ejection' claim. They think it is more likely that the quasars are 'pinches' in the Birkeland current streaming along the galaxy's spin axis. However, they all agree with Arp that the quasars are physically associated with their parent galaxies. All agree that the occurrence of the Big Bang is now extremely doubtful.

In addition to the above evidence, the ***intrinsic*** redshift z values of quasars seem to be quantized.[185] That is to say, those calculated values are tightly grouped around a series of discrete values.

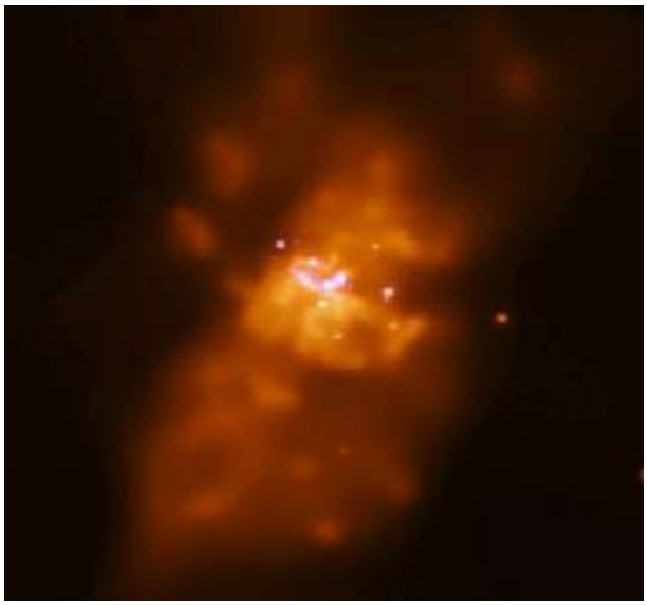
The existence of such quantization is sufficient proof of the failure of the idea that redshift is only an indicator of recessional speed (and therefore distance). This quantization means (under the redshift equals distance interpretation) that quasars must lie in several concentric shells, with Earth at the center of the entire arrangement. Copernicus discovered a long time ago that Earth isn't at the center of anything.

Recently a group of astronomers,[186] having analyzed a large number of

observed high redshift values, announced that they could find no such quantization effect. But the ***raw*** (observed) redshift value is not what is quantized. It is the quasars' ***intrinsic*** redshift *z* values[187] that are. The raw values can be smeared out away from the quantization peaks by two different Doppler velocity effects:

1. The system's motion – the family (parent galaxy and its offspring quasars) is moving as a group, either away from us or toward us.
2. The velocity components of the individual members of each quasar pair.[188] Due to their ejection from the parent galaxy, one is moving toward us, and the other is moving away.

In his new book[189], Arp shows that, when the observed *z* values are corrected for these two Doppler motions, the resulting intrinsic redshift values occur only on the quantization peaks with almost no dispersion. One must first identify which quasars are associated with each parent galaxy and ***then trans-form their observed redshift values into the parent galaxy's reference frame***.



Credit: NASA/CXC/SAO/PSU/CMU

Figure 71: Galaxy M82 in Chandra x-ray image

Figure 71 presents an image taken by the Chandra orbiting x-ray telescope of galaxy M82. (Also see figure 59.) This image shows another example of the

quasar ejec-tion phenomenon.

The official caption[190] says:

> Chandra Images Seething Cauldron of Starburst Galaxy. Chandra x-ray image of M82, at a distance of 11 million light years from Earth, is the nearest starburst galaxy. Massive stars are forming and expiring in M82 at a rate ten times higher than in our galaxy. The bright spots in the center are supernova remnants and x-ray binaries. These are some of the brightest such objects known. The luminosity of the x-ray binaries suggests that ***most contain a black hole***. The diffuse x-ray light in the image extends over several thousand light years, and is caused by multimillion-degree_***gas*** flowing out of M82. A close encounter with a large galaxy, M81, in the last 100 million years is thought to be the cause of the starburst activity. [Emphasis added.]

'Hot gas' must be extremely hot to radiate X-rays. Even orthodox astronomers will admit that all the atoms in such a hot gas are ionized and that the 'gas' is actually a plasma. But the electrical properties of a plasma can cause it to emit x-rays at much lower temperatures. Because astronomers are unaware of such properties, they must call upon the much weaker properties of gravity to supply the energy. Mathematical extrapolation indicates that the necessary energy would be available if matter were concentrated into a 'black-hole.' Although no black hole has ever been observed, the presence of one is often inferred and then announced as fact – as it is here.

In the image shown in figure 71, a string of at least five high-intensity, young, x-ray-emitting plasmoids (quasars?) extends along the spin axis of M82. There is a high level of ***plasma*** activity. High-amplitude electric currents undoubtedly are producing large pinch forces that create these objects. No black-hole magic is needed.

If there is a black hole in the middle of each of these objects, why is matter pouring ***out*** rather than ***in***? There is an old saying: "When you hear hoof beats, do not automatically assume the presence of zebras." When there is a powerful ***ejection*** of energy and material, it is not logical to immediately postulate the presence of a black hole that supposedly sucks everything ***in.***[191]

There are many exciting images taken by the Hubble space telescope of

phenomena astronomers attribute to galactic collisions. Figure 72 is an example. The typical official commentary is as follows:

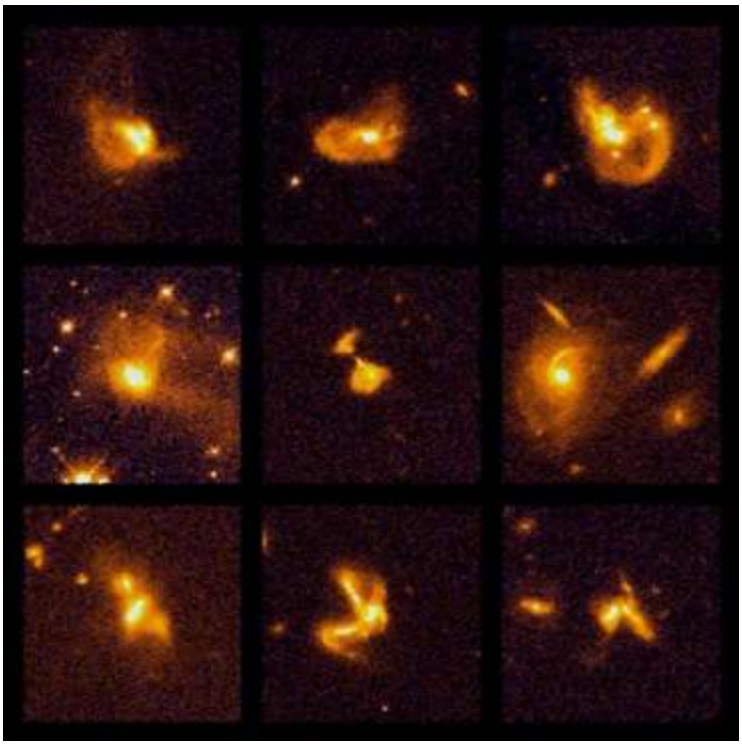
> Hubble astronomers conducting research on a class of galaxies called ultra-luminous infrared galaxies (ULIRGs) have discovered that over two dozen of these are found within 'nests' of galaxies, apparently engaged in ***multiple collisions*** that lead to ***fiery pile-ups*** of three, four or even five galaxies ***smashing together***. [Emphasis added.]

In view of Arp's observations, what we are most likely seeing is the riotous ***birth*** of galaxies and quasars, not their deaths. Instead of witnessing collisions, we are looking at the ***separation*** of parent and offspring.

Hubble astronomers seem to have forgotten how empty 'gravitational space' is: Remember the dust motes that are miles apart: Random collisions in such vacuous spaces are extremely unlikely. And if the universe were really expanding, everything should be getting farther away from everything else. Collisions should be even more improbable.

Many years ago the philosopher Benedict Spinoza commented[192]:

> It is very rare for men to relate an event simply as it happened, without adding any element of their own judgment. When they see or hear anything new, they are, unless strictly on their guard, so occupied with their own preconceived opinions that they perceive something quite different from the plain facts seen or heard … for most people think they sufficiently understand a thing when they have ceased to wonder at it.



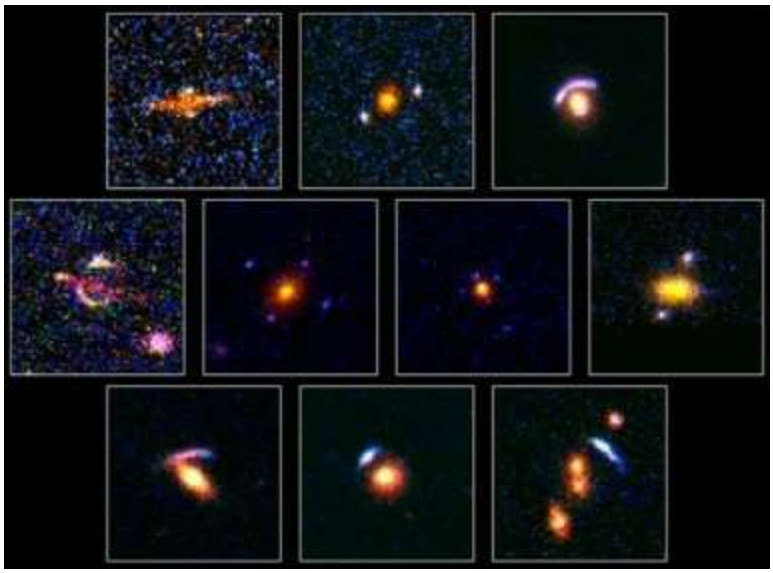
Credit: NASA, Kirk Borne (Raytheon and NASA Goddard Space Flight Center, Greenbelt, Md.), Luis Colina (Instituto de Fisica de Cantabria, Spain), and Howard Bushouse and Ray Lucas (Space Telescope Science Institute, Baltimore, Md.)

Figure 72: ULIRGs giving birth.

Astronomers are presently trying to explain away observations of quasar-galaxy connections with the hypothesis of 'gravitational lensing.'[193] Below, in figure 73, are ten examples of such groupings. The only way such an optical illusion could occur is if Earth, a nearby galaxy, and a distant quasar (all three) fall precisely on a single straight line. Could this happen once?

Possibly. But dozens of times? Not likely. In fact, the probability is vanishingly small.

And if Halton Arp is correct, the quasars are not that far away in the first place.



Credit: Kavan Ratantunga (CMU) and NASA.

Figure 73: Examples of quasars and their parent galaxies that are interpreted as ‘gravitational lensing’ effects.

These sets of objects are not illusions or mirages – rather, they are visual proof that Arp is correct in what he says: Young, high-redshift objects are being ejected in jets and arcs of plasma from the centers of active galactic nuclei (AGNs) and Seyfert galaxies. The images show exactly that happening.

The eminent astronomer Geoffrey Burbidge, a professor of physics at the University of California at San Diego, has remarked[194] that he is not concerned by the fact that some astronomers find Arp’s data unconvincing, but he objects strongly to their attempts to brush such anomalous data under the rug. His remarks are pertinent to all of science:

> Evidence of the kind just mentioned which is favorable to the cosmological interpretations[195] of the redshifts does not negate the other evidence. It simply means that the world is a complicated place. … In articles such as that by Weedman, it is somehow considered all right to totally ignore the non-cosmological hypothesis.
>
> The fairest way to deal with the problem is not to fall back on authority (what eminent authorities believe or don’t believe) but to examine the evidence for oneself. The most extensive collection of this evidence is in the book[s] by Halton C. Arp…. If, after examining the statistics yourself and understanding the evidence, you are

> unconvinced, so be it. Remember, if the conventional view is correct, all of these apparent juxtapositions must be accidental. Above all, do not be swayed by the views of the authorities, be they Dan Weedman, Allan Sandage, Maarten Schmidt, Chip Arp, or myself. We are fallible, too, and some of us (ask the others.) have axes to grind.

Our galaxy, the Milky Way, has two much-smaller companion galaxies called the Large Magellanic Cloud (LMC) and the Small Magellanic Cloud (SMC). These two objects are only readily visible to observers south of the equator. Recently a search was made for quasars 'behind' each of these galaxies. Astronomer Tom Van Flandern, previously of the Naval Observatory, brought the results[196] to the attention of an email group of which I am a member:

> Figures ... show the distribution of quasars behind the Large and Small Magellanic Clouds. They are obviously more numerous within the cloud boundaries than outside them. However, the selection criteria are not rigorous and may be biased. The distribution is sufficiently denser close to the clusters as to suggest that many of the quasars are members of these two clusters. This of course presumes that cosmological redshift is not a valid distance indicator.

Amy Acheson answered Van Flandern:

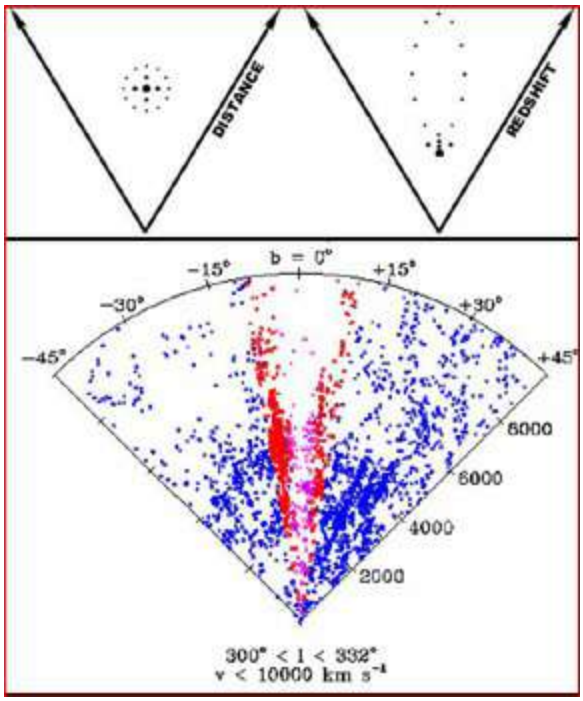
> Thanks for taking the time to send the AJ article. It's really an amazing article about the LMC. They even sneak in, especially if you look closely at the pictures, quasars lined up along the minor axis of the SMC, along filaments, and a histogram … that shows quantization of redshift, exactly as expected by Chip Arp.

If these observations are confirmed to be quasars, they will be the nearest such objects yet discovered.

It is often amazing how different investigators can look at the same data and come to opposite conclusions about its meaning. Patterns (or quantizations) can be obvious to some observers and invisible to others – especially to those who do not wish to see them.

Consider the pattern called, 'The Fingers of God.' The bottom diagram in figure 74 is supposedly a plot of the distances[197] to many of the galaxies that lie in a ninety-degree field of view centered on the Virgo Galaxy Cluster

(whose members are shown in red). The distance measurement for each galaxy was computed by presuming that its actual distance is proportional to its redshift value.



Credit: AAO Newsletter, Aug 1996**.**

Figure 74: The Virgo galaxy cluster as 'Fingers of God.'

What is actually plotted is ***redshift value vs. angular position.*** As a result, the Virgo cluster takes on the shape of two long fingers pointed directly at Earth. These have become known as 'The Fingers of God.'

Long cosmic-sized fingers pointed directly at Earth? This is absurd on its face. It is independent proof that the 'redshift equals distance' assumption is false. Earth is not the center of the universe (nor is it the focal point for the Virgo galaxy cluster).

If the lower plot in figure 74 had included larger radial 'distances,' then the strings of red dots that represent the Virgo cluster objects would have closed as shown in the upper right plot in the figure. The plot would form an elongated ellipse. But, the high-redshift galaxies in the upper regions of this plot are not far away, they are just young – and are at approximately the same distance from us as the low-redshift galaxies. Arp points out that the Virgo cluster is much more compact than it appears in the lower diagram. A plot of the correct distance distribution is shown in the diagram at the upper left in

figure 74.

How astronomers can continue to look at this diagram and not realize that something is wrong with the 'redshift equals distance' idea is evidence of how blinded by this assumption they have become. Like the Church in Galileo's day, refusing to open its eyes to any version of the order of the cosmos but its own, today's astrophysicists have closed their eyes and minds to observations that might disprove their dogma.

Carl Sagan put it this way, "You can't convince a believer of anything; for their belief is not based on evidence, it's based on a deep seated need to believe."

It is ironic to remember that Galileo got into trouble with the Church by promoting the work of Copernicus who said that Earth is not the center of anything. In pointing out the erroneous nature of the Fingers of God diagram, Arp is indeed today's Galileo.

A detailed discussion of Einstein's General Relativity Theory is well beyond the scope of this book. However, for completeness, we should briefly discuss how Arp's work impinges on the ***assumptions*** that were made in solving Einstein's famous equation. That equation can be written, in its simplest form, as[198]

$$G = T,$$

where T represents the energy and momentum of a system of particles and G describes the geometry (e.g., curvature of space-time) of the space in which the particles reside. Note carefully that this postulated relationship does not explicitly include any electrical or magnetic phenomena.

In 1922 a Russian mathematician, Alexander Friedmann, derived a solution to the general form of this equation, which yielded the now famous result that the spatial separations of the particles in the cosmos have to increase with time. This was the genesis of the notion that space itself was expanding. The very coordinate system in which we measure the positions of objects in the universe was blowing up. Redshift could be decoupled from recessional velocity, distance could be made 'stretchable,' and the Big Bang could be anchored to a non-empirical mathematical structure into which any observation could be subsumed. It was overlooked that such a deduced hypothesis was not falsifiable and thus made cosmology into a pseudoscience. It was not until 1977 that mathematician Jayant Narlikar[199]

pointed out that Friedmann's solution had ***assumed*** that the total mass of all the particles in the universe remained constant in time. Narlikar did ***not*** make that particular assumption and obtained a different solution – one wherein $m = at^2$. This result indicates that the ***mass*** of the cosmos increases at a rate that is proportional to the square of the age of that mass. It isn't the ***size*** of the universe that is getting larger – it is its ***mass***.

Arp points out in his book *Seeing Red*[200] that "the most useful feature of the Narlikar solution is that it explains [my] preceding book[s] full of observations. If particle masses are a function of time, then younger (more recently created) electrons have smaller masses. When a less massive electron makes a transition between atomic orbits, the photon involved has a lower energy and the resulting spectral line is redshifted. The consistent lesson of the observations we have discussed is, the younger the object, the higher the intrinsic redshift."

Einstein was not necessarily wrong when he postulated his relation. The error lay in the ***assumptions*** made by others when they solved that equation. It was wrong to presume that the mass of the cosmos is constant. That single faulty assumption has led to the present disaster of curved space-time, expanding space, Big Bang, Dark Energy, inflation theory, and a host of immeasurable, nonsense quantities – none of which can be observed. Contrast all this to Narlikar's elegant, closed-form solution of the Einstein equation. This solution results in a conclusion that has been repeatedly verified by Arp's experimental evidence – his observations and his images.

Dr. Halton Arp's contributions to observational astronomy and the way he has been treated by the majority of the astronomical community are reminiscent of the story of Plato's cave[201]. Imagine a dark, cave-like prison in which humans are bound by their necks to a single place from infancy. All they can see are shadows on the opposite wall of the cave. The real objects are beyond their field of vision. A fire behind the real objects creates the shadows. The prisoners do not recognize their imprisonment and are satisfied to live their lives in this way. Then one man gets free and struggles to where he sees the real objects. This freed prisoner now understands the shadows to be imperfect, twisted copies of the full reality now grasped in his mind. But when he is returned to the prison, the freed prisoner becomes the object of ridicule, disbelief, and hostility. His observations are rejected as being

‘obviously flawed.’

Any unbiased scientific examination of Arp’s images will quickly lead to the conclusion that it is not his evidence and his images that are flawed. Rather, the flaw is in the established and convoluted theory at whose foundation lies a mistaken solution of Einstein’s postulate, the unwarranted presumption that the total mass of the universe must be a constant and the now falsified assumption that ‘redshift implies large distance and recessional velocity.’

Real evidence leads us to conclude that Halton Arp is correct in his contention that redshift is caused mainly by an object’s being young and only secondarily because of its velocity. Therefore, quasars are not the brightest, most distant, and most rapidly moving objects in the observed universe – but they are among the youngest. And the Virgo galaxy cluster most certainly does not have the shape of a long ‘Finger of God‘ pointed directly at Earth. And the universe is not expanding.

We have noted that Arp’s contention that quasars and BL Lac objects are ***ejected*** from active galactic nuclei is somewhat contrary to Peratt’s and Alfvén’s theory that they are ***formed in place*** by z-pinches in cosmic Birkeland currents. But these two proposed mechanisms are not contradictory: Arp’s ejection is accompanied by much plasma activity; Peratt’s z-pinches occur in plasma streaming out of a galaxy along its axial current. In either case, the hypothesis is antithetical to the Big Bang Theory. Both agree that quasars are in close proximity to (and in dozens of cases connected to) their central galaxies.

The story of Halton Arp demonstrates the extent to which the astrophysics power structure will go in defending their theories and assumptions even when confronted with clearly falsifying evidence. Worst of all are their attempts to stifle Arp’s publications.

What can be called ‘The Arp Affair’ should have been stopped early on by heeding Carl Sagan’s judgment: “The suppression of uncomfortable ideas may be common in religion or in politics, but it is not the path to knowledge, and there’s no place for it in the endeavor of science.”

Chapter 18

Lowering the Drawbridge

When astronomers realized they could accurately predict solar and lunar eclipses by using the mathematics of Johannes Kepler and also explain why the planets move as they do by using Newton's Law of Gravitation, they thought their quest for knowledge about how the cosmos works was just about complete. They then retreated into a fortress-like mentality, pulling up the drawbridge behind them.

Later they allowed Einstein into the castle and tried to emulate his mathematics. Some particle physicists gained entry, too, provided they swore to support and defend the theories of the resident astronomical wizards who lived behind the walls. Mystical tales of black holes and strange matter began to float down to the public from the battlements – tales that the public did not understand but that added great stature to those telling them. Astronomers never again allowed outsiders into the castle.

It is time for the drawbridge to be lowered again so that astronomers and astrophysicists can learn about experimental plasma physics. That they need to know about the electrical properties of the cosmos ought to be abundantly clear from reading this book. But this is just one aspect of a more widespread and insidious problem that pervades much of today's scientific world.

The advent of Big Science has made enormous research projects possible. Two bicycle makers may have been able to design and create the first flying machine, but they never could have created a rocket capable of landing on and returning from the Moon. That took billions of government-supplied dollars and large research and development teams and facilities.

Big Science has also brought with it Big Control. No one wants to waste huge sums on dubious lines of investigation, so tight reins are understandably placed on the expenditure of these vast sums. But these constraints have led to a narrow focusing of science. Those empowered to hold those reins are excessively tight in some ways and much too loose in others.

Biologist Rupert Sheldrake[202] describes it this way:

> In the Nineteenth Century, Darwin, for example, put forward radical

> ideas. He didn't have to deal with the science establishment because at that time amateurs like him worked independently in whatever area interested them. He never had an academic post. He didn't have a government grant. He worked as an independent scientist from his country home in Kent, and he could say what he liked. Nowadays very few scientists have that independence. Younger ones are dependent on short-term contracts and on the patronage of their superiors, which makes them very frightened – very conservative – very afraid to step out of line. More senior scientists are dependent on the flow of grants and funds which depends on yet higher-up people in the science establishment approving their work and thinking they are good chaps and so on. And the effect of all this is to make people extraordinarily frightened of stepping out of line. Science, in its ideology, sees itself as doing fearless exploration of the unknown. Most of the time it's a fearful exploration of the almost known.

Sheldrake also said recently that big "science has a kind of Stalinist mentality – a kind of central committee, planning out research strategies and awarding grants in an atmosphere of fear throughout the scientific community. People don't dare to step out of line."

This 'too tight' control of what is acceptable and what is not amounts to destructive censorship. Potentially fruitful areas of research are aborted before they can be born.

However, when it comes to funding completely abstract and non-testable work in areas such as String Theory, the reins are much too loose. Purely abstract research, where no testing in the real world is possible or even desired by those investigators, ought to receive only limited government funding. There should be a statute of limitations on any such funding. If wealthy universities and private foundations want to endow these sorts of purely intellectual activities in perpetuity, it should be their option to do so.

We cannot (nor would we want to) return to the days of Darwin. Big Science is with us to stay. But there are a couple of ways to return it to a more reasonable course – a true search for knowledge. Senior scientists who have become mired in established thought must be persuaded to be more open to new ideas. If non-testable sciences were to become more tolerant of reasonable alternative ideas, it would lead to a more openly aware scientific

world. But scientists are human, and as we have seen, it is difficult to convince someone to reverse course or admit new ideas into a closed field wherein he has been a mover and shaker for decades.

It may well be that the challenges we have described in these pages will slowly seep into the purview of younger, more open-minded students who will eventually attain research positions at major institutions. After achieving some degree of security there, these people may then be able to quietly introduce some of these ideas. One can hope they will then be honest enough to give credit where credit is long past due – to the Alfvéns, Langmuirs, Birkelands, and Peratts, and not just say those ideas are now 'well-known.'

Right now, however, if you try to obtain an entry level position on the faculty of any prestigious Department of Astronomy and suggest that the Big Bang Theory may be flawed, if you reveal that Halton Arp's photographs interest you, if you refer to the possibility that electric fields and currents might be involved in the workings of the cosmos, you will be quietly (but quickly) shown to the door.

Political commentator David Horowitz, speaking about the structure of institutions of higher learning, asked,

> How has this monopoly of the academic campus come about? To begin with, universities are feudal institutions whose organizational structures are hierarchical and collegial and thus closed to scrutiny and oversight. The dean … confessed that there was absolutely nothing he could do to alter the situation. Faculty hiring is controlled by senior members of the faculty itself, at the departmental level. Unless bound by greater scruples, they can hire – and do hire – only people who agree with them and share their prejudices.

Horowitz was talking about the political prejudices of university faculties, but his comments are equally relevant in all branches of the academy and science.

The public thinks that the major activity of pure science is the dispassionate search for new truths. The sad reality is that these days the search for truth usually takes a back seat to other activities. What researchers do now for the most part is try to survive. This means that they must constantly seek funding from friendly peer reviewers. Scientists strive to attain the admiration of their colleagues in competing institutions and

government funding agencies. They seek mutual acceptance and stature as a means of survival. They seek (and many times are successful in attaining) control of funding agencies.

Science needs to be encouraged to revisit the principle that theories can be revised or even discarded without dishonoring the investigators who developed those earlier paradigms. It is perfectly proper for revisions in any scientific field to be sparked by new researchers – even those from outside that field – especially when they are people of the intellectual stature of Kristian Birkeland and Nobel laureates Hannes Alfvén and Irving Langmuir. Rather than feelings of shame, true scientists should be proud of reversing course. "Once you embrace unpleasant news, not as a negative but as evidence of a need for change, you aren't defeated by it. You're learning from it."[203] You should be proud of it.

If persuasion and education do not achieve a more open mindset in those who steer the ship of science, higher authority can enforce changes in the leadership of funding agencies.

When non-testable, speculative 'science' competes for funding with experimentally testable research, the testable work ought to receive priority – at least from governmental sources. Most aspects of Plasma Cosmology are testable in the laboratory. This is the kind of research that NASA should fund. They should be more circumspect in providing support for areas in which it is difficult or impossible to test hypotheses. Congress could direct such a change.

Billions of taxpayer dollars have been used to support 50 years of failed research on controlled nuclear fusion experiments. A good portion of this research is based on erroneous fundamental assumptions about how plasma and magnetic fields interact. A similar huge investment in astrophysics has produced little more than a cascade of whimsically named invisible entities, mysterious mechanisms, stories about magnetic bubbles, and other strange complexities – all case-hardened in opaque mathematics. If these fields had been more open to new ideas, they would have had better chances of achieving meaningful results.

Perhaps each funding agency ought to be required to set aside a certain small amount each year to be awarded only to research proposals that ***challenge*** accepted theories. This is not to advocate the financial support of

baseless bad science but rather of ideas that are well founded on previous work, hopefully on ***experimental*** work.

Rupert Sheldrake has suggested[204] that if only ***one percent*** of the money now being distributed by scientific funding agencies were to go to research that was of real interest to taxpayers, science would become more popular. At present, tax money generally goes to research sought by the scientific establishment, corporations, and government institutions. The administration of science is neither accountable to those who pay for it nor carried out in an unbiased way.

Sheldrake's proposal suggests that 99 percent of research funds continue to be allocated in the usual way. But he suggests that a board representing a wide range of interests, including non-governmental organizations, schools and voluntary associations, allocate the one remaining percent. A possible name would be the National Discovery Center.

Individuals could submit suggestions over the Internet. Local and national organizations could lobby for projects. Potential subjects for research could be discussed in the news media. Sheldrake feels this new venture would make science more attractive to young people, stimulate interest in scientific thinking and hypothesis testing, and help break down the depressing alienation from science that many people feel. Whether the funding is directed to "address the curiosity of lay people" or toward the goal of supporting more scientifically based (but paradigm challenging) research is really not all that important. What is crucial is that, one way or another, we must break the monopoly that establishment science now has over which hypotheses and phenomena can be looked into and which cannot.

The late renowned astronomer, Dr. Thomas Gold, proposed instituting a formalized procedure where informed, scientifically astute people from outside an area could judge whether a new idea should be funded for investigation. He called this formalism a 'scientific court.' Gold said,

> Where a lot is at stake, where a subject has been driven into an alley, one must set up a science court where the different viewpoints would be heard, would be argued by the protagonists of each one, with carefully prepared work. The different viewpoints could be judged, not by others working in that same field, which would merely take you back to the herd, but would be judged by a group of very

> knowledgeable and very competent scientists distributed over other fields, but with enough general competence to be able to understand the detailed arguments of the field in question. I would be much happier to have subjects surveyed every now and again by a jury of that kind. It has to be a scientific jury because it would have to understand detailed scientific arguments, but they do not have to be – and should not be – from the field in which the decision is to be made.

Gold also criticized the peer review system's[205] constrictive grip on new ideas. "Why is it thought that the peer review system would work for science? How about trying to make a peer review system work for other forms of endeavor? Suppose we had a national foundation for the arts, and every painter had to apply to it to get his canvas and his brushes and his paints. How do you suppose that would work?"

Perhaps one way to break the cycle of the peer review system's awarding all government and most private funding to only those scientists who promote the dominant theory is to encourage the practice of wealthy patrons supporting new, less-mainstream scientific investigations – as the Medici family did for Galileo.

I know a bit about astronomy and a fair amount more about electric plasma. I have no formal training in archeology, anthropology, or geology. But I suspect the shoe fits there as well as in astronomy and cosmology. This is because all the experiences I have ever had with representatives from those areas of science that deal with non-testable past and distant realms have resulted in my being told with supreme authority that everything those experts were saying was accurate, correct, and precisely known. And they brook no suggestions of alternative hypotheses.

But everyone realizes that no one can know with certainty exactly what happened in the unreachable past. All we can do is accumulate circumstantial evidence, just as a district attorney does in attempting to convict someone. If the wall of circumstantial evidence gets high enough and solid enough,[206] if his facts corroborate each other, then we say the DA has proved his case beyond reasonable doubt. The evidence has to be ***solid*** and it has to be ***logical*** and ***reasonable.*** His evidence has to withstand scrutiny. The prosecutor cannot bring into court invisible witnesses we cannot talk to. If new evidence becomes available, he has to consider it fairly. If he doesn't want to do that,

the judge should make him do so or disqualify him.

Isn't that what science is all about – collecting data, building and testing theories, and drawing dispassionate, rational conclusions based on all possible alternative interpretations? Truth is what is important. The prejudices of power structures do not constitute a valid falsification of a well-founded hypothesis. Truth is not determined by how many papers are published or how many people believe them but by which theory best accounts for observed facts – which one is simpler – which one is based on and consistent with experimental testing.

The ideas embodied in the Electric/Plasma Universe – despite many of its founders having won Nobel Prizes – have ***not*** been impartially investigated in the astrophysics academy. Will it take another several hundred years (as it took Galileo) to gain official acceptance of these electrical hypotheses by those who constitute the power structure in astrophysics? Will science in general become more open to new ideas? Does this question have practical importance?

You bet your pocket book it does. NASA's yearly budget is in the order of fifteen ***billion*** dollars – that is your tax money – and they have stated openly that they simply will not fund any cosmological research that is adverse to the Big Bang, which for them has become a religious conviction.

Even Carl Sagan, who was not a plasma cosmologist once said, "It is far better to grasp the universe as it really is than to persist in delusion, however satisfying and reassuring."

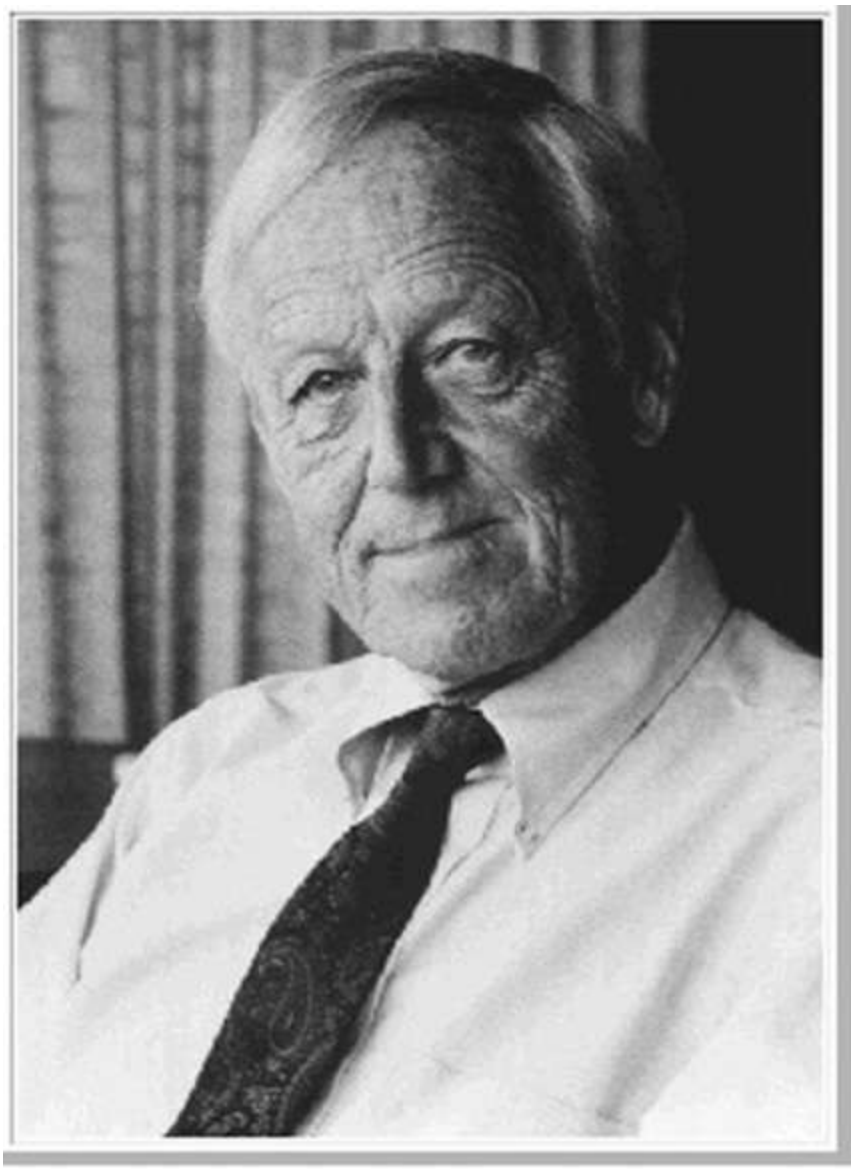
Why is it so important that Plasma Cosmology gain wider recognition? The answer is because ***people want to get it right***. Nobody wants to be intellectually deceived and sold an expensive bill of goods that is untrue. Sagan put it this way: "Finding the occasional straw of truth awash in a great ocean of confusion and bamboozle requires intelligence, vigilance, dedication, and courage. But if we don't practice these tough habits of thought, we cannot hope to solve the truly serious problems that face us – and we risk becoming a nation of suckers, up for grabs by the next charlatan who comes along." These pages have attempted to show that the spokesmen for modern cosmology and astrophysics have become those charlatans, selling their engaging, confusing, mystical tales to the funding agencies and to the innocent public.

So, here is the challenge: Right now the proponents of the Electric/Plasma

Universe are gathering outside the fortress of astrophysics and are calling up to the battlements, “You folks up there – raise the shades, open the windows, and look out. Lower the drawbridge!

You have been in self-imposed darkness too long. Many advances have been made in an area of engineering-science that has been developed since the time you hauled up that drawbridge – it is called ***experimental electric plasma dynamics***. Raise your eyes from your deductive Relativistic-Newtonian gravity-only mathematics and look up at the real night sky.

It’s an ***Electric Sky.***”



Credit: The Royal Institute of Technology, Stockholm.

Plate 10: Dr. Hannes Alfvén (1908-1995)

Appendix A

Birkeland currents

The Maxwell-Lorentz equation:

[redacted]

describes the acceleration (time rate of change of momentum) experienced by a particle, moving with velocity, v, in a magnetic field, B, that is carrying electric charge, +q. The force experienced by the particle will be at right angles to the direction of its velocity.

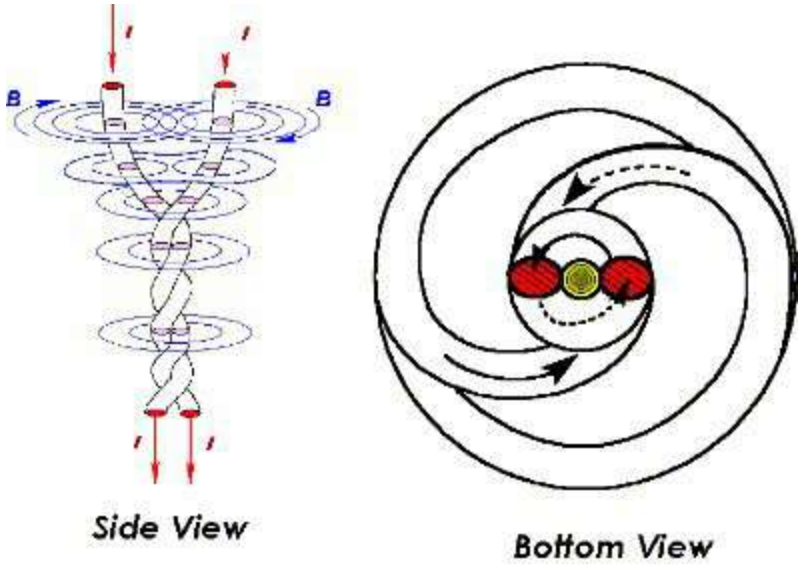


Figure A1: Typical Birkeland current showing the central z-pinch region.

If the initial velocity of the particle is perpendicular to the magnetic field, the path that the particle takes is a circle in the plane perpendicular to the field. However if the initial velocity of the particle is at an angle different from 90º to the magnetic field (perhaps slightly in the same direction as the field), then the path will be a helix, a spiral. This is shown in figure A1. The stronger the field is, the smaller the radius of the circle will be. An important result of this interaction is that, no matter what the initial direction of the current stream (before it entered the magnetic field), this current ends up following the direction of the magnetic field.

Often in the laboratory and in the cosmos, a pair of such spiraling currents

will be observed. This interlinked pair will at first be magnetically drawn together. But after a certain proximity is achieved, a force of repulsion is generated that holds them apart. This configuration is extremely stable. The resulting tightly wound pair is called a Birkeland current. The attractive/repulsive forces acting on this pair of currents creates a twisted, cylindrical volume inside the spiral (see the exact center of the bottom view shown in figure A1).

It is within this constricting central volume that extreme compression of matter can take place.

When this occurs in cosmic space "the magnetic flux tubes are not directly observable themselves, but the associated plasma filaments can often be observed by the radiation they emit."[207]

When several different chemical elements are contained within such a region of compression, they do not mix homogeneously. Rather, they tend to distribute themselves radially according to their ionization potentials. This effect was studied by G.T. Marklund[208] and is now called Marklund convection.

While discussing Marklund convection, Peratt[209] also says, "The most abundant elements of cosmical plasma can be divided into groups of roughly equal ionization potentials as follows: He (24eV); H, O, N (13eV); C, S (11eV); and Fe, Si, Mg (8eV)…. These elements can be expected to form hollow cylinders whose radii increase with ionization potential. Helium will make up the most widely distributed outer layer; hydrogen, oxygen and nitrogen should form the middle layers, while iron, silicon, and magnesium will make up the inner layers. Interlap between the layers can be expected and, for the case of galaxies, the metal-to-hydrogen ratio should be maximum near the center and decrease outwardly…. Mirabel and Morras[210] (1984) have detected the inflow of neutral hydrogen toward our own galaxy."

Any time charges are accelerated (as they are in the case of a Birkeland current) "synchrotron" electro-magnetic radiation at various frequencies occurs – typically from microwaves through hard x-rays.

Appendix B

Computation of Redshift Values

In light of Halton Arp's flood of evidence, it is becoming clear that an object's total redshift value is the product of its ***intrinsic*** redshift factor times its ***velocity*** factor. (E.g., if an object's intrinsic redshift value is, say, 0.3, and its velocity redshift is 0.06, then the total redshift factor that will be measured in light coming from this object is given by (1+0.3)(1+0.06) = 1.378.

In other words, for this example, the object's light is redshifted 30% due to its youth and then that light is shifted ***another*** 6% due to its velocity. The total is not the sum (36%) but rather 37.8%. (Recall the grade school math question: If you earn 10% on your stock investment this year and 20% next year, how much will your original amount have increased? Answer: 1.10 x 1.20 = 1.32 → 32%, not 30%.)

The wavelength of any given line in this object's spectrum will be multiplied by 1.378 as compared to the wavelength of that line when it is measured in the laboratory. The *total* multiplying factor (1+ z_t) is, therefore, made up of two multiplicative factors.

$$(1 + z_t) = (1 + z_i)(1 + z_v) \quad (1)$$

where z_i is called the "*intrinsic* redshift of the object" and z_v is the "redshift due to *velocity*" of the object.

There Are Three Redshift Components

Suppose we are given the raw, observed, redshift value of a quasar. In order to determine the value of the intrinsic redshift of that quasar we must remove the effect of two different velocity components. This calculation is done as follows.

Visualize a pair of quasars, q_1 and q_2, one on either side of a parent galaxy, *G*. The redshift of quasar q_1 is due to three causes:

1. The entire family: G, q_1, and q_2 are moving through space together.

This velocity of the entire family sets the “reference frame” of the family.

2. The velocity of the quasar, with respect to the reference frame, in the direction of the line of sight.

3. The intrinsic redshift of the quasar. This is the quantity that we want to determine (it is the value that is quantized).

There is a two-step process that must be done for each quasar pair in order to arrive at the intrinsic value of their redshift.

1. Find the value of the velocity of the parent galaxy (the reference frame).

2. Find the value of the velocity of each quasar with respect to this reference frame.

Transposing to the Rest Frame of the Parent Galaxy

First, if the parent galaxy has a significant redshift due to velocity, that component must be removed from all QSOs associated with that galaxy.

Dr. Arp gives[211] an example of a parent galaxy UM 341 and several pairs of associated quasars. In this case the parent galaxy has a redshift of z_G = 0.399 and one associated pair of QSOs are z_1 = 0.718 and z_2 = 0.879. Using equation 1:

$$\frac{(1+z_1)}{(1+z_G)} = (1+z_{1G})$$,

we find 1.718 / 1.399 = 1.228
and 1.879 / 1.399 = 1.343,
giving the two partially corrected quasar redshift values z_{1G} = 0.228 and z_{2G} = 0.343.

Arp calls these values the “quasar redshifts after they have been transposed to the reference frame of their parent galaxy.”

As another example of this calculation, Arp points out that: “It is also

interesting to note that the redshift of Mrk 205 (z = 0.070), when transformed to the rest frame of the disturbed galaxy, NGC 4319 (z = 0.006), becomes z = 0.064. This is very close to the first quantized redshift value, z = 0.06."

Velocities in the Line of Sight

At this point in the calculation we have redshift values for the quasars that have been transposed to their common reference frame as described above. Unless the quasars are moving away from their parent galaxy in a direction that is exactly orthogonal to our line of sight, one will be approaching us somewhat, and one will be going away. Thus, within this moving frame of reference of the parent galaxy, the quasars' ***velocity*** redshift values are equal in magnitude but opposite in sign. Their intrinsic redshift values are identical to each other. Their transposed (to the reference frame) values of total redshift are z_{1G} and z_{2G} respectively. From equation (1) we have

$$(1+z_i)(1+z_v) = (1+z_{1G})$$

and $(1+z_i)(1-z_v) = (1+z_{2G})$

Expanding each of these yields

$$1+z_i+z_v+z_iz_v = (1+z_{1G})$$

and $1+z_i-z_v-z_iz_v = (1+z_{2G})$.

Adding these two expressions yields:

$$2+2z_i = 2+z_{1G}+z_{2G}$$

or $z_i = \frac{z_{1G}+z_{2G}}{2}$. (2)

Therefore we see that the intrinsic redshift value of a pair of symmetrically placed quasars is simply the arithmetic mean of the individual transposed quasar redshift values.

Example (continued):

The transposed quasar redshift values as determined above are z_{1G} = 0.228 and z_{2G} = 0.343. Assuming both have identical intrinsic redshift components, we calculate this value via the arithmetic mean:

z_i = (0.228+0.343)/2 = 0.2855.

Note that this calculated intrinsic redshift value, 0.2855, is only Δ = -0.0145 from one of the quantum levels, 0.300. ***This*** is the calculation astronomers who are critical of Arp's ideas refuse to perform.

We can then calculate the velocity redshift component for each quasar via equation (1), as follows:

$$\frac{(1+z_{1c})}{(1+z_{i})} - (1+z_{v1}),$$

1.228 / 1.2855 = 0.955

which yields

z_{v1} = 0.955 – 1 = –0.045

and

$$\frac{(1+z_{2c})}{(1+z_{i})} - (1-z_{v2}),$$

1.343 / 1.2855 = 1.045

which yields

z_{v2} = 1.045 – 1 = +0.045

The quasar with the negative velocity redshift value is moving away from its parent toward us and the one with positive velocity redshift is receding (each at 4.5% of the speed of light with respect to the parent galaxy).

We observe that the reference frame redshift value (of the parent galaxy), z = 0.399, is also Δ = 0.099 different from one of the quantum levels, 0.3. If, indeed the intrinsic redshift of the central galaxy is 0.3, a calculation similar to the above indicates it is receding from us at:

$$\frac{1.399}{1.30} = 1.076$$

or 7.6% of the speed of light, 22,800 km/sec.

Appendix C

Solar Electron Flux

The solar constant, defined as the total radiant energy at all wavelengths reaching an area of one square centimeter at the Earth's distance from the Sun, is about 0.137 watts per square centimeter[212]. It works out, then, that the Sun must be emitting about 6.5×10^7 watts per square meter of solar "surface," and the total power output of the Sun is approximately 4×10^{26} watts.

The hypothetical electric discharge must then have a power input of 4×10^{26} watts. Suppose that the Sun's cathode drop is of the order of 10^{10} volts. Then the total power input divided by the cathode drop is 4×10^{16} amperes. The velocity of the stellar winds is estimated at 200 – 1000 km/s[213]. This is in the range 2×10^5 and 10^6 m/s. Therefore, let us suppose that the effective velocity of a typical interstellar electron is at least 10^5 m/s. From current estimates of the state of ionization of the interstellar gas, we might conclude that there should be at least 100,000 free electrons per cubic m. The random electric current of these electrons then would be $I_r = Nev$ where N is the electron density per cubic meter, e is the electron charge in coulombs, and v is the average velocity of the electrons (in m/s). Using these values, we find that the random electric current density should be about 1.6×10^{-9} Amp per square meter through a surface oriented at any angle.

The total electron current that can be drawn by the solar discharge is the product of the random current density and the surface area of the sphere occupied by the cathode drop. There is little to indicate how large this sphere might be, but in view of the enormity of the cathode drop it seems likely that the radius of the sphere would be large in terms of solar system dimensions. The mean distance of Pluto's orbit is 39.5 AU, or about 6×10^{12} meters. We know that the cathode drop reaches to at least that distance from the Sun. It seems reasonable to estimate the distance of the heliopause[214] is at least twice

that radius so that its spherical boundary would have a collecting surface area of something greater than $4x10^{26}$ square meters.

Such a surface could then collect a current of interstellar electrons amounting to approximately $1.6x10^{-9}$ Amp per square meter x $4x10^{26}$ square meters = $4x10^{17}$ A. (Exactly 10 times the number needed) – and of course a larger heliosphere could collect an even greater current.) Of course this calculation involves many estimated quantities, but the point is that it is ***not*** reasonable to conclude that there are not enough electrons to power the Sun. From the rough estimates of these important quantities that are presently the best available, we have determined that there most certainly are more than enough electrons available to power the Sun if, indeed, that is what is occurring.

Appendix D

An Open letter to the Scientific Community

The Big Bang is by far the dominant theory of the history of the Universe. Yet today it is based on an ever-growing number of hypothetical entities: the inflation field, non-baryonic matter (dark matter) and the dark energy field are the most prominent examples. Contradictions between observations and Big Bang predictions are “resolved” by the introduction of such entities, entities that we cannot or do not observe. The theory also requires the violation of two of the best-tested laws of physics: the conservation of energy and matter as well as the conservation of baryon number (which states that equal amounts of matter and anti-matter are created from energy).

In no other field of physics would the continuous introduction of new hypothetical entities and new physical laws be considered as an explanation for serious contradictions between theory and observation. In any other field, the repeated need for such entities would, at least, raise serious questions about the validity of the underlying theory, if not result in its invalidation.

The Big Bang is not the only available framework for describing the history of the Universe. There are alternative explanations for the basic phenomena of the cosmos, including the abundances of light elements, the generation of large-scale structure, the cosmic background radiation, and the Hubble relation.

Yet such questions and such alternatives cannot now be freely discussed and examined. An open exchange of ideas is now lacking in most mainstream conferences. While “science is the culture of doubt”, as Richard Feynman put it, in cosmology today doubt and dissent are simply not appreciated and young scientists quickly learn to remain silent unless they have something positive to say about the standard model. Even the data is now interpreted through this biased filter. An observation is judged right or wrong depending on whether or not it supports the Big Bang. At the same time virtually all financial and experimental resources are devoted to Big Bang studies. This reflects a growing dogmatic mindset that is alien to the spirit of free scientific

inquiry. This cannot be a healthy situation.

As scientists, we feel that the restriction of funding, and access to experimental equipment, to work within the Big Bang framework contradicts the fundamental commitment of the scientific method to the constant testing of theory against observation. Such a funding restriction makes unbiased discussion and research impossible.

A return to a less dogmatic approach would be healthy for the astronomical sciences and especially for cosmology. We strongly urge that government agencies that fund work in cosmology set aside a significant fraction of their funding for investigations of alternatives to the Big Bang and of observational contradictions to the Big Bang. We propose that the peer review committee that allocates such funds be composed of astronomers and physicists from outside the field of cosmology. By funding, even at a modest level, investigations into the Big Bang's validity, and elaborations of alternatives, this proposal would allow the scientific process itself to determine the most valid model of the history of the universe.

Initial signers:
(Institutions for identification only)

Andre Koch Torres Assis, State University of Campinas (Brazil)
Yuri Baryshev, Astronomical Institute, St. Petersburg State University (Russia)
Ari Brynjolfsson, Applied Radiation Industries (USA)
Hermann Bondi, Churchill College, Cambridge (UK)
Timothy Eastman, Plasmas International (USA)
Chuck Gallo, Superconix, Inc.(USA)
Thomas Gold, Cornell University (emeritus) (USA)
Amitabha Ghosh, Indian Institute of Technology, Kanpur (India)
Walter J. Heikkila, University of Texas at Dallas (USA)
Michael Ibison, Institute for Advanced Studies at Austin (USA)
Thomas Jarboe, Washington University (USA)

Jerry W. Jensen, ATK Propulsion (USA)
Menas Kafatos, George Mason University (USA)
Bo Lehnert, Royal Institute of Technology, Stockholm (Sweden)
Eric J. Lerner, Lawrenceville Plasma Physics (USA)
Paul Marmet, Herzberg Institute of Astrophysics(retired) (Canada)
Paola Marziani, Istituto Nazionale di Astrofisica, Osservatorio Astronomico di Padova (Italy)
Gregory Meholic, The Aerospace Corporation (USA)
Jacques Moret-Bailly, Université Dijon (retired) (France)
Jayant Narlikar, IUCAA(emeritus) and College de France (India,France)
Marcos Cesar Danhoni Neves, State University of Maringá (Brazil)
Charles D. Orth, Lawrence Livermore National Laboratory (USA)
R. David Pace, Lyon College (USA)
Georges Paturel, Observatoire de Lyon (France)
Jean-Claude Pecker, College de France (France)
Anthony L. Peratt, Los Alamos National Laboratory (USA)
David Roscoe, Sheffield University (UK)
Malabika Roy, George Mason University (USA)
Sisir Roy, George Mason University (USA)
Konrad Rudnicki, Jagiellonian University (Poland)
Domingos S.L. Soares, Federal University of Minas Gerais (Brazil)
John L. West, Jet Propulsion Laboratory, California Institute of Technology (USA)
James F. Woodward, California State University, Fullerton (USA)

There are now over 400 signatories to this letter.

Credit: NASA/HST

Plate 11. Galaxy NGC 4650A. A classic example of the Alfvén model shown in figure 57.

Image by the author.

Plate 12: The Eagle Nebula M16 is a large interstellar emission plasma – said to be the “birthplace of many stars”.

Because in the beginning was the plasma.

readership…. I felt genuine excitement while reading and felt I was delving into a delicious feast of new ideas."

– **Gerrit L. Verschuur, PhD,** University of Manchester. He is a well-known radio astronomer and writer, presently at the Physics Department, University of Memphis. He is the author of *"Interstellar matters : essays on curiosity and astronomical discovery*", and *"The invisible universe – The Story of Radio Astronomy"* as well as many other books and scientific papers.
: the story of radio astronomy". ISBN 0387962808

"You don't have to be an astronomer to enjoy this book. It's an exciting story about how a small group of physicists, engineers and other scientists have challenged the 'establishment' – the 'big science' astronomers who are reluctant to listen to anyone outside their own elite circle."

– **Lewis E. Franks, PhD,** Stanford University, Fellow of the IEEE (1977), Professor Emeritus and Head of the Department of Electrical & Computer Engineering, University of Massachusetts (Retired).

"Gravity was the focus of 20th century astronomy. For the 21st century, it will be electromagnetism and plasmas in addition. This forthcoming scientific revolution is presaged by the rapid pace of discoveries about our own star, the Sun, and its total plasma environment, and discoveries about the nature of the interstellar medium."

– **Timothy E. Eastman, PhD,** Head of Raytheon's space physics and astrophysics groups. He is well known for his work on magnetospheric boundary layers and the initial discovery of the Low Latitude Boundary Layer.

http://www.plasmas.org/space-astrophys.htm

"It is gratifying to see the work of my mentor, Nobel Laureate Hannes Alfvén enumerated with such clarity. I am also pleased to see that Dr. Scott has given general readers such a lucid and understandable summary of mu own work."

– **Anthony L. Peratt, PhD,** USC, Fellow of the IEEE (1999), former scientific advisor to the U.S. Department of Energy and member of the Associate Laboratory Directorate of the Los Alamos National Laboratory. He is the author of *Physics of the Plasma Universe* and numerous published papers.

1 E.J. Lerner, Private communication.

2 "Double Layers and Circuits in Astrophysics," Hannes Alfvén, *IEEE Transactions on Plasma Science*, Vol. PS-14, No. 6, Dec. 1986

3 The fundamental mathematical relationships upon which all of mankind's electrical knowledge is based.

4 Other books by Alfvén (1908-1995) are: *On the Origin of the Solar System* (1954); *Atom, Man and the Universe* (1964); *Worlds – Antiworlds: Antimatter in Cosmology* (1966); *The Great Computer: A Vision* (1968); *Living on the Third Planet* (1972); *Evolution of the Solar System* (with G. Arrhenius) (1976).
Also see http://plasmauniverse.info

5 *Cosmic Plasma*, by H. Alfvén, D. Reidel Pub., 1981.

6 The SOlar and Heliospheric Observatory. http://sohowww.nascom.nasa.gov/

7 See Appendix D – An open letter to the scientific community signed by leading plasma engineers and physicists.
8 On site
9 Roger Bacon (*On Experimental Science* - 1268) said that "without experiment it is impossible to know anything thoroughly." See: http://www.fordham.edu/halsall/source/bacon2.html

10 William of Occam (1280-1349), http://www.utm.edu/research/iep/o/ockham.htm
11 Popper, Sir Karl Raimund (1902-1994), said that it is impossible to verify or confirm a universal scientific theory. All that can be done is to ***dis***prove a theory. No number of observations can confirm a hypothesis, but all it takes is one contradictory observation to refute a hypothesis. http://plato.stanford.edu/entries/popper/
12 Thomas H. Huxley (1825-1895).
13 See: http://math.about.com/library/blpostulate.htm
14 This is called epistemology – the study of the origin, nature, methods and limits of knowledge.
15 See: http://en.wikipedia.org/wiki/Socratic_method

16 *Op. cit.*

17 *Cosmic Plasma*, by H. Alfvén, D. Reidel Pub., 1981, p 5.
18 *Op. cit.*
19 *Do Androids Dream of Electric Sheep?*, Philip K. Dick (1928-1982)
20 In logic this is called the fallacy of *argumentum ad ignorantiam*, meaning "argument from ignorance." The fallacy occurs when it is argued that something must be true, simply because it hasn't been proved false.
21 The fallacy: If A, then B; B is true; therefore, A is true. (If it is raining, the street is wet. The street is wet. Therefore, it must be raining.) This neglects the possibility that a street cleaning machine just went by.
22 http://chandra.harvard.edu/photo/2003/goods/index.htm GOODS Chandra Deep Fields: The Secret Lives Of Galaxies Unveiled In Deep Survey
23 http://antwrp.gsfc.nasa.gov/apod/
24 A "cosmogonist" is one who is concerned with the formation of the planets and other members of our solar system. A "cosmologist" is one who investigates the origins of the universe – with emphasis on objects that typically lay beyond our solar system. There is not universal agreement on these definitions, but they do have general acceptance among astronomers.
25 Personal communication, E.J. Lerner.

26 Helioseismology is discussed in the chapter on our Sun.
27 “The Physics of the Sun and the Gateway to the Stars,” Eugene N, Parker, *Physics Today*, June 2002.
28 The Einstein Cross is discussed in detail in chapter 4.
29 The original Big Bang Theory did not include magnetism because it was claimed there were no magnetic fields in space. Only since the direct measurement of magnetic fields in galaxies in 1986 was a need created for a mechanism to explain their existence. Even now astrophysicists have problems deciding on what causes cosmic magnetic fields. (The answer is – cosmic electric currents.)
30 *Astronomy*, June 2003, p.26
31 That move at speeds faster than light.
32 Halton Arp was Edwin Hubble’s student and assistant. He was a long-time observer at the Mt. Palomar and Mt. Wilson telescopes. We will discuss his work in detail in chapter 17.
33 *Burnham’s Celestial Handbook*, Robert Burnham, Jr. (Staff member Lowell Observatory 1950-1979), Dover, NY, 1978.
34 http://planet.iap.fr/lens.html Paul Vreeswijk's Grootonderzoekscriptie (Master's Thesis), which was submitted as a requirement for his doctoral degree in

June 1996 at the Rijksuniversiteit Groningen, in the Netherlands.

35 Microlensing planets in M 22: Free-floating or bound? By R. de la Fuente Marcos and C. de la Fuente Marcos Universidad Complutense de Madrid, Ciudad Universitaria, 28040 Madrid, Spain **Abstract** We use detailed numerical simulations and theoretical estimates to show that, if confirmed, the unusually brief microlensing events observed by Sahu et al. (2001) in the field of the globular cluster M 22 might be explained as a result of microlensing by a population of clustered MACHOs, a dark cluster or RAMBO, not associated with the globular cluster. Also see: http://bustard.phys.nd.edu/MPS/

36 A hypothetical form of energy that supposedly permeates all of space and which produces a force that acts in opposition to gravity. This is needed in order to explain the observation that the expansion of the universe appears to be accelerating and gravity only attracts; it does not repel. (Electrical forces both attract and repel.)

37 *Astronomy*, Aug. 2001, p 26

38 "New Light on Dark Matter," *Science*; 6/20/2003, Vol. 300, Issue 5627, p1909

39 *Astronomy*, op cit.

40 Cardassian Expansion: A Model in Which the Universe is Flat, Matter Dominated, and Accelerating," Katherine Freese and Matthew Lewis, *Physics Letters*, 2002.

41 *NY Times Book Review* 1/1/2006

42 1st Crisis in Cosmology Conference, Moncao, Portugal, June 2005.

43 See Appendix D.

44 Eric J. Lerner, Personal communication.

45 For two protons, the electrostatic force of repulsion between them is 1.2×10^{36} times the force of their gravitational attraction. The electrostatic repulsion between two electrons is 4.2×10^{42} times their gravitational attraction. For one proton and one electron, the electrostatic force of attraction between them is 2.2×10^{39} times the force of their gravitational attraction.

46 In a fusion reaction, two hydrogen atoms fuse first to form a deuterium atom (an isotope of hydrogen with 2 nucleons), a positron and an ***electron neutrino***. Then the deuterium fuses with another hydrogen to form helium-3 and a photon of energy. Finally two helium-3s fuse, forming a helium nucleus and two hydrogen nuclei.

47 "Physicists: Neutrinos Have Some Mass," Matt Crenson, AP article appearing on-line in *The Nando Times*, June 19, 2001.

48 http://www.sno.phy.queensu.ca/sno/first_results/
49 This is a *tautology* or *truism*, something that is always true (independent of the phrase that precedes it).
50 March 4, 2005
51 March 30, 2006, Press contact: Kurt Riesselmann, Fermilab Public Affairs, 630-840-3351, kurtr@fnal.gov
52 Langmuir, Irving (transcribed and ed., Robert N. Hall). "Pathological Science," *Physics Today*, 42 (Oct. 1989): 44.
53 He introduced the (erroneous) concept of an imaginary "equant" point about which the epicycle traveled, with constant angular velocity.
54 This observation proves that Venus revolves around the Sun.
55 Ben Franklin had made some comments about the aurora perhaps being electrical but did not follow up on this idea.
56 1873
57 Alfred a Knopf, NY, 2001, p. 170
58 Emission of Light and Very low frequency perturbations from Electromagnetic pulse Sources or ELVES, (Lyons and Nelson, 1995).
59 NGC 7293
60 "Double Layers and Circuits in Astrophysics,"

Hannes Alfvén, *IEEE Transactions on Plasma Science*, Vol. PS-14, No. 6, Dec 1986.

61 Vol. PS-14 No. 6

62 http://plasmauniverse.info

63 Within the solar wind, at Earth's distance from the Sun, there are something like 5 to 60 million electrons per m^3. In interstellar space, the density is of the order of 1 million per m^3.

64 But there will be a slight voltage drop between any two points in any real plasma.

65 Peratt, *Physics of the Plasma Universe*, p. 37.

66 "Magnetically Self-focusing Streams," W.H. Bennett, *Phys. Rev*. **45** 890.

67 "Table 1.5 Parameters associated with the interstellar medium," Peratt, *Physics of the Plasma Universe*, p. 15.

68 "Cosmic strings" should not be confused with "String Theory," which is a wholly different invention. See:
http://www.damtp.cam.ac.uk/user/gr/public/cs_evol.htm
vs. http://www.superstringtheory.com/

69 Synchrotron radiation is electromagnetic emissions generated by circular (spiral) motion of electrons along a magnetic field, e.g., in Birkeland currents.

70 *The Fourth State of Matter*, Bova, B., Pub. St. Martin's Press, 1971

71 “The Physics of the Sun and the Gateway to the Stars,” Eugene N. Parker, *Physics Today*, June 2000, p. 26-31.
72 The photosphere is a weakly ionized plasma.
73 The absolute temperature scale is measured in units called “Kelvin” (not degrees Kelvin – just Kelvin).
74 The lower corona is a strongly ionized plasma.
75 http://www.alma.nrao.edu/science/basics/solarwind.htm
76 In a ***pnp*** transistor, increasing the height of the base-emitter voltage barrier reduces the amount of charge injected from the emitter into the base region. This, in turn, reduces the collector current.
77 Parker [op cit.]
78 Power is the product of voltage times current. Electron flux is one component of the current. The question of the Sun’s voltage also remains unanswered – but is crucial to the calculation of power output.
79 Electric current ***density*** (in Amps/m^2) is analogous to the river’s flow ***density*** (in gallons per minute/$meter^2$).
80 *Cosmic Plasma*, p.22.
81 See figure 10.
82French word meaning “beach.”
83“Double Layers and Circuits in Astrophysics,” Hannes Alfvén, *IEEE Transactions on Plasma Science*,

Vol. PS-14, No. 6, Dec 1986.

84C. Jacobson and P. Carlqvist, *Icarus*, Vol. 3, p. 270, 1964.

85 *Evolution of the Solar System*, Carlqvist, 1969; Babic et al., 1971; Torven, 1972; Bostrom, 1974, NASA document SP-345, Chapter 15.

86 http://soi.stanford.edu/press/ssu8-97/

87 "The Physics of the Sun and the Gateway to the Stars," *Physics Today*, June 2000, p.28.

88If you point your right thumb in the direction of the current, then your curled fingers will show the direction of the magnetic field that encircles the current.

89A secondary current will always flow in a direction that tends to ***oppose*** the growth of the magnetic field that induces it. This relationship can be seen in figure 21.

90The end of a compass needle marked "N" is indeed a north magnetic pole. It points almost toward Earth's north pole. Thus, the region near Earth's North Pole (toward which the compass points) is, in reality, a *south* magnetic pole. A magnetic field is leaving the compass needle and flowing into the earth near the north geographic pole. That field then comes out of the Earth near the geographic south pole (creating there a north magnetic pole) and then flows into the end of the

compass needle marked “S”.

91The word *dynamo* was coined by electrical engineers to describe the machine that we now call an electric voltage or current *direct current generator*. The word was never used to describe the production of a magnetic field as it is here. Magnetic fields are produced by electric currents in *coils*, *inductors* and *transformers*, not by the movement of hot gases.

92The divergence of any magnetic field is zero, $\nabla \bullet B = 0$.

93Like “singularities”, field lines are abstractions and cannot be reified into being real, material objects.

94“The Paradox of the Sun’s Hot Corona,” Bhola N. Dwivedi and Kenneth J.H. Phillips, *Scientific American*; June 1, 2001.

95http://www-istp.gsfc.nasa.gov/Education/ then click on Magnetospheres and the Universe. Also see: http://www.pppl.gov/projects/pages/magnetic_reconnec

96http://www.physicstoday.org/pt/vol-54/iss-10/p16.html

97 $B = \frac{\mu_0}{4\pi}\frac{2i}{r}$, where i is the total current carried by the two wires, r is the distance, and μ_0 is the permeability (a property of the space in which the experiment is performed).

98 This type of field is termed a “vector field.”

99See:

http://www.physics.montana.edu/faculty/cornish/lagran
100“Double Layers and Circuits in Astrophysics,” *IEEE Trans. On Plasma Sci.*, Vol. PS-14, No. 6, Dec. 1986.
101W.J. Heikkila, *Astrophys. Space Sci.*, Vol. 23, p. 261, 1973.
102http://mrx.pppl.gov/ Then click on Physics.
103“Double Layers and Circuits in Astrophysics,” H. Alfvén, *IEEE Trans. On Plasma Sci.*, Vol. PS-14, No. 6. Dec 1986.
104US-Japan Workshop on Magnetic Reconnection, Plasma Merging, and Magnetic Jets, "Astrophysical Reconnection and Particle Acceleration," Awaji-shima Island, Hyogo Prefecture, Japan, 8-10 March 2005.
105 The Moon’s surface does bear remnant magnetism. The rocks returned to Earth by our Moon landings showed evidence of this magnetism. Unfortunately, the orientation of the rocks prior to removal was not recorded.
106 101.3 kilopascals
107 Electrical engineer Edward V. Appleton investigated these and other properties of upper atmospheric plasma. He was awarded the Nobel Prize in 1947 for this work and also the IEEE Medal of Honor in 1962.
108 Except for occasional lightning strokes.

109 $O_2 \rightarrow O_1+O_1$ and then $O_1+O_2 \rightarrow O_3$.

110 http://www-istp.gsfc.nasa.gov/Education/ then click on Exploring Earthspace

111 See chapter 12.

112 http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/97

113 http://www.wikipedia.org/wiki/Van_Allen_radiation_be

114 http://www.holoscience.com/news.php?article=s9ke93mf

115 http://sohowww.estec.esa.nl, 3D reconstruction of solar corona as observed by UVCS.

116 Lighting Up The Van Allen Belts – Stanford - December 6, 1999

117 http://www.aip.org/pt/vol-54/iss-11/p41.html

118 This should not be confused with a 'tidal lock' which keeps the same face of a body *always* facing another body (such as the Moon is with Earth).

119 This complex crater in the Navka region of Venus was mapped by Magellan on September 26-27, 1990 during orbits 459 and 460.

120 One new image of the active volcano Prometheus on Io has been compared to one of the same features taken by NASA's Voyager spacecraft 17 years ago, and shows that the plume is now erupting from a position about 46.5 miles west of where the hot spot

resided in 1979.
See: http://www.jpl.nasa.gov/galileo/status961023.html
121 JPL manages the Galileo mission for NASA's Office of Space Science, Washington, DC. This image and other images and data received from Galileo are posted on the World Wide Web on the Galileo mission home page at http://www.jpl.nasa.gov/galileo. Background information and educational context for the images can be found at http://www.jpl.nasa.gov/galileo/sepo.
122 New Scientist October 30, 1999.
123 Under the 'gravity-only' theory, stars and planets supposedly form via a process that condenses matter which is first distributed in a disk shape into spheres. Astrophysicists now have defined several 'types' of these such as: 'dust disks', 'debris disks', and 'proplyds'.
124 In figure 37, prominent dark spokes are visible in the outer half of Saturn's broad B Ring in this Voyager 2 photograph taken on Aug. 3, 1981, from a range of about 22 million kilometers (14 million miles).
125
http://hubblesite.org/newscenter/newsdesk/archive/relea
126
http://www.guardian.co.uk/life/science/story/0,12996,1
127 Sawyer, Kathy, LATimes-Washington Post

Services, 6 Nov 2003.
128 32.6 light-years
129 Harlow Shapley was his student.
130 Recently, the “Johnson B-V index” often replaces the Spectral Class scale. B = blue, and V = visual. A star is viewed through a blue (pass) filter and then in visible light. The star’s “color index” is the difference in apparent magnitude between the two observations. B-V is zero for the star Vega (spectral class A0), and is about 0.61 for the Sun which is redder than Vega. Red giant Betelgeuse has a B-V index of 1.83 and spectral class M2. Originally, the B-V index was simply the difference between a star’s visual and photographic magnitudes.
131 “Gravitational collapse” is another *ad-hoc* invention.
132 A plasma in the normal glow mode emits faint light in comparison to one in arc mode.
133 http://antwrp.gsfc.nasa.gov/apod/ap000712.html
134 *Solaria Binaria* – deGrazia & Milton. Metron Pub., Princeton, NJ 1984.
135 If the split results in two unequally sized spheres, the increase in total area will be less than 26%.
136 More total surface area and no change in total current produces a lowered overall current **density** (A/m^2)**.**

137 *CCD Astronomy*, Summer 1996, p.40.
138 http://www.nrl.navy.mil/pao/pressRelease.php?Y=1996&R=2-96r
139 *Aeon*, Vol. V, No. 5, Jan. 2000, p. 37.
140 A **forbidden line** is a spectral line emitted by atoms undergoing energy transitions not normally allowed by the selection rules of quantum mechanics. There is, however, a non-zero probability of their occurrence, should an atom or molecule be raised to an excited state in a low density plasma. So they do occur.
141 Yet again.
142 "Radiation Properties of Pulsar Magnetospheres: Observation, Theory, and Experiment," *Astrophys. Space Sci*., 227 1995.
143 From http://www.seds.org/messier/more/m001_hst.html
Hester et.al., 1995, "WFPC2 Studies of the Crab Nebula. I. HST and ROSAT Imaging of the Synchrotron Nebula," *Astrophysical Journal*, Vol. 448, p. 240-263 and plate 10-15 (July 20, 1995).
144 "Faraday modestly described his epochal discovery of the world's first electric dynamo as 'A New Electrical Machine' in a paper before the Royal Society in London on Nov. 24, 1831." – *Empires of Light*, J. Jonnes, pub.Random House 2003. p.41.
145 *The Norwegian Polaris Expedition 1902-1903* Pub

Christiana, 1913.

146 This is the homopolar motor described in the chapter on types of stars. Alfvén‘s electrical stellar circuit is almost identical to his galactic circuit described here.

147 Described in chapter 9.

148 The spin axis is sometimes called the “minor axis.” Jets emitted by galaxies usually coincide with this axis.

149 Private communication.

150 *3D Magnetohydrodynamical Turbulence in Astrophysical Accretion Disks*, John F. Hawley and Steven A. Balbus, U. Virginia, and James M. Stone, U. Maryland.

151 See Appendix A.

152 http://www.sciencedaily.com/releases/2001/05/010515075430.htm

153 *Annu. Rev. Astron. Astrophys.*, 1988, 26: 631-86.
http://nedwww.ipac.caltech.edu/level5/Sept01/Bahcall/I

154 *Bye Bye Big Bang Hello Reality*, William C. Mitchell, Cosmic Sense Books, 2002, p. 60.

155 Impossible because a positive result would further indict the Big Bang Theory?

156 Op. cit.

157 April 1920 “Great Debate” between Harlow Shapley and Heber Curtis. See: *Nature*, Vol. 240, pp 429-430 (1972).

158 By identifying bright Cepheid variable stars in M

31. However, his distance estimate was too close by a factor of 2 – this was corrected in the 1950's.

159 Wavelength of stellar emission line = $(1+z)*$ wavelength of same emission line measured in lab. Thus, the reported redshift value, *z*, is the *fractional increase* in the wavelength of a star's light.

160 E. Hubble, *The Realm of the Nebulae*, Yale University Press, 1936, p. 102.

161 E. Hubble, *Proc. Nat. Acad. Sci.*, 1929, 15, 168.

162 E. Hubble, Roy. Astron. Soc. M. N., 17, 506, 1937

163 At first $v=cz$. But when QSOs were observed with redshifts $z>1$, the equation was adjusted to keep v from exceeding c, the speed of light: $v = c\frac{(z+1)^2 - 1}{(z+1)^2 + 1}$.

164 Astronomers use the "Hubble Law": $v = H\,d$ where v = recessional velocity, d = distance, and H = the "Hubble constant" (~80±17 km/s/Mpc), ignoring Hubble's warnings.

165 See chapter 4.

166 NGC 4319: z = 0.0045 or 1357 km/s. Mrk 205: z = 0.071 or 21,237 km/s.

167 Digital image processing such as was used here is a standard technique. The images were treated globally – nothing was done to one part of the image that was not done to the entire frame. The technique only emphasizes what is already there in the image – it adds

nothing that was not there originally.

168 Hubble Space Telescope.

169 *Quasars, Redshifts and Controversies*, Interstellar Media, Berkeley, CA., 1987 p. 36.

170 "Two emission line objects with z>0.2 in the optical filament apparently connecting the Seyfert galaxy NGC 7603 to its companion." Authors: M. Lopez-Corredoira, Carlos M. Gutierrez. http://arxiv.org/PS_cache/astro-ph/pdf/0203/0203466.pdf

171http://quasars.org/

172 *Seeing Red*, pp 14-15.

173 arXiv:astro-ph/0401103, v18, Jan 2004.

Astronomy & Astrophysics, January 8, 2004, "New optical spectra and general discussion on the nature of ULX's," H. Arp[1], C. M. Gutierrez[2], and M. Lopez-Corredoira.[3]

1 Max-Planck-Institut für Astrophysik, Karl Schwarzschild-Str.1, Postfach 1317, D-85741 Garching, Germany

2 Instituto de Astrofisica de Canarias, E-38200 La Laguna, Tenerife, Spain

3 Astronomisches Institut der Universität Basel, Venusstrasse 7, CH-4102 Binningen, Switzerland

174 Seyfert Galaxies are spiral galaxies with unusually bright, tiny cores that fluctuate in brightness. Most are powerful sources of infrared radiation. Some emit intense radio, X ray, and gamma rays.

175 p. 96-101

176 NGC 7320 z = 0.0026; NGC 7317 z = 0.022; NGC 7318A z = 0.022; NGC 7318B z = 0.019; NGC 7319 z

= 0.023; NGC 7320C z = 0.020.

177 See, for example, http://www.chandra.harvard.edu/photo/2003/stephan/in

178 Remember, if we stand facing south and look up at the night sky, east is to our left and west to our right. Most (but not all) astronomical images are published in this orientation.

179 *Quasars, Redshifts and Controversies*, H.Arp, 1987, pp 88-89.

180 NGC 1232 z = 0.0053; NGC 1232A z = 0.022.

181 "The Discovery of a High Redshift X-ray Emitting QSO Very Close to the Nucleus of NGC 7319," http://arxiv.org/abs/astro-ph/0409215, Authors: Pasquale Galianni, E.M. Burbidge, H. Arp, V. Junkkarinen, G. Burbidge, Stefano Zibetti.

182 NGC 3320, 3963, 5248, 5656.

See http://www.quasars.org/qso-gals/default.htm

183 BL Lacertae objects (BL Lac for short) exhibit no emission lines but have a strong continuum stretching from radio frequencies through X-ray frequencies.

184 See Appendix B for the details of the calculation.

185 QSO redshifts cluster at z = 0.061, 0.30, 0.60, 0.91, 1.41, 1.96, … such that $(1+z_2)/(1+z_1) = 1.23$.

186 Hawkins, Maddox, and Merrifield (M.N.R.A.S. 336, L13, 2002).

187 To make this calculation, we first must identify a

pair of quasars symmetrically positioned on either side of a galaxy and measure the redshift of each; then calculate the average value. This average value is the inherent redshift of the pair. This is the quantity that has been observed to be quantized.

188 See Appendix B.

189 *Catalogue of Discordant Redshift Associations*, H.C. Arp, Apeiron, Montreal, pp. 58, 59.

190 http://chandra.harvard.edu/photo/2001/0094true/

191 To explain this contradiction, astrophysicists now say some black holes can radiate energy, via a mechanism known as Hawking radiation, named after the British physicist Stephen Hawking who first invented the idea. This avoided the necessity of having to propose a wholly new invisible entity – or accept Alfvén‘s model.

192 *A Theologico-Political Treatise*, 1670 (Pub Anon.), Benedict de Spinoza (1632-1677)

193 See the section on Gravitational Lensing in chapter 4.

194 Burbidge, Geoffrey; “Quasars in the Balance,” *Mercury*, 17:136, 1988.

195 Astronomers use the phrase “cosmological distance” to imply that the redshift equals distance assumption is correct. The phrase “non-cosmological hypothesis” refers to Arp’s ideas.

196 “Quasars. Distribution behind Magellanic clouds,” *AJ* 125, 1-12 (2003).

197 What is plotted are redshift-dictated *indicative velocities.* The assumption is made that use of the Hubble constant can then reveal the *distance* of each of these galaxies.

198 This description is described by Arp, *Seeing Red*, p. 225-252.

199 *Annals of Physics*, 107, 325.

200 P. 227.

201 Adam, James. *The Republic of Plato*. 1902. 2nd Ed. Cambridge: Cambridge University Press, 1963.
Annas, Julia. *An Introduction to Plato’s Republic*. Oxford: Clarendon Press 1981.

202 Sheldrake is the author of several widely read books. Among them are: *The Sense of Being Stared At; Seven Experiments that Could Change the World: A Do-it-Yourself Guide to Revolutionary Science;* and *Dogs That Know When Their Owners are Coming Home*. http://www.sheldrake.org/

203 Bill Gates, Chairman, Microsoft Corp.

204 “Really Popular Science,” Rupert Sheldrake, *New York Times* January 4th 2003

205 “New Ideas in Science,” Dr. Thomas Gold, *Sci. Exploration*, Vol. 3, No. 2, pp 103-112, 1989.

206 This is sometimes called *inductive* reasoning.

207 *Physics of the Plasma Universe*, Anthony Peratt, Springer-Verlag, 1992, pp 165, 166.
208 "Plasma convection in force-free magnetic fields as a mechanism for chemical separation in cosmical plasmas," G.T. Marklund, *Nature*, **277** 370 (1979).
209 Op. cit. pp 167-168.
210 "Evidence for High Velocity Inflow of Neutral Hydrogen Toward the Galaxy," *Astrophysics J.* **279** 86.
211 *Catalogue of Discordant RedshiftAssociations*,- Halton C. Arp, Pub. Apeiron, 2003. ISBN 0-9683689-9-9. pp 58-60.
212 R.C. Wilson, *Journal of Geophysical Research*, 83,4003-4007 1978.
213 Peratt, A. *Physics of the Plasma Universe*, Springer-Verlag, 1992.
214 Astronomers now estimate that the region of "termination shock" (the heliopause) surrounds the solar system in a giant sphere at distances ranging between 85 and 120 times Earth's 93 million-mile distance from the sun. This is in the order of 8 billion miles = 1.48 x 10^{13} meters. Thus our estimate of 6 x 10^{12} meters is on the conservative side.